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THE FUNCTION OF IMITATION IN INFANCY

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ABSTRACT

In this thesis I consider three theories of representation. From the most important of these, Piaget's theory, specific successes and failures of infant representational ability can be predicted.

A series of experiments designed to test certain aspects of that theory are accordingly reported. In Experiments I - IV, young infants (aged 3 - 16 weeks) were found to have a limited ability to imitate the eight models of movement shown to them. In Experiment V it was found that older infants, by contrast, were unable to imitate a novel hand and arm movement. In Experiments VI - VIII infants and young children were not immediately successful in a task in which literal and pictorial representational information had to be used to solve the problem.

The discovery that young infants were able to imitate certain models is irreconcilable with the evidence from the classic studies on smiling, which indicate that the young infant's ability to discriminate adult features is not sufficiently well developed to allow for imitation. In this thesis, I report the results of a study of smiling which show that young infants can discriminate adult features, supporting my contention that imitation is possible. Smiles in visually impaired and in blind infants were compared in form with those found in normal infants. Presence and absence of particular form changes seem to indicate that some aspects of the smile are learned, possibly through imitation.

The implication of these results for theories of representation outlined are discussed, and possible models of imitative behaviour considered.

THESIS DECLARATION

The work reported in this Thesis is my own, having been completed between 1971 - 74 and 1976 - 78 within the normal terms of reference of supervision as a part-time Ph.D. Student in The Faculty of Social Science, Edinburgh University.

Jane Dunkeld.

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CHAPTER I

THEORIES OF REPRESENTATION

Piaget's theory and observations of the function of imitation in the development of representation, are of inestimable value to any investigation of imitation. It is essential then to describe that theory of the emergence of representation. However, before considering Piaget's and other theorists' views of representation in infancy, "representation" itself must be defined.

Representation in one sense is understood as an act of evocation of an absent image or object. When an infant successfully reproduces the action of a model, when that model is no longer present, then representation in this first usage must obviously be taking place.

Representation is commonly understood in another sense, as an image or symbol which exhibits the counterpart of some material object or idea. When an infant can understand that a picture or word actually denote a particular object, then representation in this sense is understood.

PIAGET'S THEORY

"Representation begins when there is simultaneous differentiation and co-ordination between 'signifiers' and 'signified'. The first differentiations are provided by imitation and the mental image derived from it, both of which extend accommodation to external objects. The meanings of the symbols, on the other hand, come by way of assimilation, which is the dominating factor in play and plays an equal part with accommodation in adapted representation.

... The constitution of the symbolic function is only possible as a result of this union between actual or mental imitation of an absent model and the 'meanings' provided by the various forms of assimilation. Then it is that language, a system of collective signs, becomes possible."

(Piaget 1945/62).

I have given this somewhat lengthy quotation in full, because I believe it to be Piaget's clearest statement on the development of representation in both the senses outlined above. Representation is not possible in the first sense until the infant can show imitation of an absent model, as the image only becomes available when this capacity has been developed. Representation in the second sense is not evident until imitation has provided the first differentiations, when the symbols acquire meaning through play. When both these forms of representation are developed, language acquisition may proceed. Piaget defines his use of representation as

"The capacity to evoke by a sign or a symbolic image an absent object or an action not yet carried out" (Piaget 1936/53),

where a sign is a collective arbitrary symbol, such as a word, and a symbol is a mental image.

Piaget holds that representation is not possible in the sensorimotor period.

"At the level of groping, representation does not precede action and does not even directly result from it." (Piaget 1936/53)

Because the infant in this stage is restricted to direct co-ordinations of actions, mental imagery is not possible. When an infant uncovers an object in order to strike it (Piaget, 1936, 53 Obs. 129), the infant need not picture the object before uncovering it. The familiar sensor-motor schema of striking objects is sufficient to lead him to his shoe, with which he is often used to strike objects. Piaget illustrates the unlikelihood of mental imagery being present in the sensor-motor phase with reference to his observations on the characteristic errors obtained in object permanence tasks, which could hardly occur if the

infant had access to an image of the vanished object (Piaget and Inhelder, 1966/71). He also illustrates this with reference to the problem of pulling a stick through the bars of a cot, when it is presented horizontally against the bars (Piaget, 1936/53 Obs. 162-163). The child persists in pulling the stick against the bars, and cannot intentionally adjust the angle of the stick to allow it to pass through the bars. This would be inexplicable if the child could form a mental image of how the stick should be adjusted.

Although symbols are not available to the child in the sensorimotor phase, there are certain cues which Piaget terms "indices" and "signals" which permit "prevision" of events independent of action itself (Piaget, 1936/53), seen in instances of anticipation of events. However, these predecessors of the true signifier cannot be classed as true symbols. The symbolic image can only be formed when the schemata begin to function in mental assimilation and accommodation.

"The mental image is a product of the internalisation of the acts of intelligence" (Piaget, 1936/53).

For Piaget, the bridge between sensorimotor representation and operational representation is imitation.

"... imitation, first altered and interiorised, indubitably constitutes the starting point of the mental image" (Piaget, 1967/71).

Piaget argues that the capacity of the child to reproduce the actions of others externally, by imitating them, leads to the capacity to imitate these internally. In imitating a model no longer present, the external model has been replaced by an "internal model" (Piaget, 1945/62). This internal model takes the form of an image, and thus constitutes the first signifier, indicating that representation has developed. However,

"The image must in some way be acted before it is thought" (Piaget, 1936/53).

From this it follows that the imitation precedes the image, and not that the image is followed by the act of imitation.

As progress is made in the development of representation through imitation, the continuation of accommodation, so play, the continuation of assimilation also develops (Piaget, 1945/62). During the sixth stage of the development of intelligence, because of the progress of representation brought about by deferred imitation, "Ludic symbols", which involve representation first appear. These presage the appearance of representation in the second sense described above. Thus at the age of 15 months J. was observed to "sleep" on "pillows" which were in fact the collar of a coat, the tail of a rubber donkey, etc. (Piaget, 1945/62 Obs. 64).

Piaget believes that in every Ludic symbol can be found representational imitation. With the systematic acquisition of language, however, these symbolic schemas can be projected on to new objects. Thus after the age of 18 months J. was observed to make her hat cry, and feed a doll with a shell (Piaget 1945/62 Obs. 75a).

Imitation, then, provides the first signifiers, leading to the formation of symbols, as mental images and ludic symbols. This development in representation constitutes the beginning of the semiotic function, which allows for the development of language. The importance of imitation in Piaget's theory of representation cannot therefore be overestimated.

BRUNER'S THEORY

Bruner, who defines representation as

"A set of rules in which one conserves one's encounters with events" (Bruner, 1966a)

has proposed that there are three modes of representation, or kinds of representational systems. These are

"enactive representation, iconic representation and symbolic representation - knowing something through doing it, through a picture or image of it, and through some symbolic means such as language" (Bruner 1966a).

The iconic and symbolic modes of representation thus correspond to the two definitions of representation presented above.

Bruner argues that these three modes of representation evolve in the order in which they were described. Their development is not stage-like, but one of successive mastery, with the partial translation of each its successor.

In the sensor-motor period enactive representation prevails, and Bruner uses Piaget's descriptions of infant behaviour to illustrate his concept of that representation. At this stage percept and action are poorly differentiated, but the infant "defines" the percept by the action. Bruner admits that the description of action patterns as modes of representing events remains obscure (Bruner, 1966a).

Iconic representation becomes possible when

"perception becomes autonomous or relatively autonomous from action" (Bruner, 1966a).

By the end of the first year of life the child is well on the way towards this accomplishment (Bruner, 1966b). The transition from enactive to iconic representation is characterised thus:

"an objectivised form of imagery taking over as the prevailing mode of summarising behavioural space, rather than behavioural space being represented by kinesthetic or proprioceptive patterns" (Bruner, 1968).

Bruner agrees with Piaget's emphasis on

"the origin of imagery in action" (Bruner, 1968)

which may indicate that he sees the image as a product of interiorised

imitation. Because of the difficulty of obtaining information as to the nature of the young child's images, he hypothesises that from reports of older children's perceptual organisation

"non-schematised imagery is highly characteristic of early intellectual operations" (Bruner, 1966b).

Bruner and his co-workers in a long series of studies have shown how the child moves from an iconic mode of representation to a symbolic mode (Bruner et. al 1966). For Bruner, however, symbolic representation is not simultaneous with the emergence of speech, since

"only slowly does (the child) learn to relate the language he speaks to his thoughts about things, to order his representation of the world by the syntactical logic inherent in his speech" (Bruner, 1966a).

Symbolic representation can only be said to be present when the child knows not only the referents of words, but the rules for forming and transforming utterances.

Bruner proposes that the "impulsion" to cognitive growth, to movement from one mode of representation to another, is conflict or contradiction.

BOWER'S THEORY

For Bower, perception is a process of representation, (Bower, 1978). Representations are "models of reality" (Bower and Wishart, 1978) according to this theory.

These models are "internal descriptions" of events. They are formed through the processes of perception, which in the young infant is abstract in nature. Thus the representations of events in the world which the young infant attains are also abstract (Bower, 1978). Bower conceives of development as a process of differentiation, whereby the original abstract perceptions of the infant give rise to abstract representations. As perception becomes more specific, and less abstract,

so do the representations the infant constructs become less abstract and more specific (Bower and Wishart 1978). Bower defines his use of "abstract" and "specific" within the Theory of Types proposed by Russell (1910), where statements are classified into types according to the level of specificity and level of logic.

Bower argues that evidence from research on perceptual and cognitive development indicates that during development the infant's internal descriptions of events do move from being abstract and less differentiated to being specific and more differentiated.

To illustrate his theory in perceptual development Bower (1978) cites a study by Day and McKenzie (1973) on short-term perceptual learning in young infants. Infants were shown a cube in a certain orientation for 10 trials of 20 seconds each, and of course they habituated. If the infants were instead shown the same cube in different orientations for 10 trials, then they habituated at the same rate. Photographs of the cube in different orientations did not produce habituation. This demonstration of shape constancy in young infants, Bower argued, (1978) showed how abstract was the infants' representation of an object. Their memory was of a cube, not of a cube in a specific orientation; so when they saw that cube in a different orientation, it was seen as being the same as the original cube. Whatever the nature of the representation of the original cube the infants possessed, it was non-iconic and abstract.

Bower cites a study by Caron et al. (1977) to support his theory that the infant's representational system is not iconic; for in that study, where 18 week old infants were presented with various shapes in various orientations using an habituation paradigm, greatest recovery to the test stimulus was found when both shape and slant of the

test stimulus were varied although the retinal image was the same. Had the infants merely retained the iconic image of the habituated stimulus there should have been no recovery to the test stimulus.

Bower believes that the experiment reported by Bryant et al (1972) also supports his view that initially representation is not iconic but is abstract. It seems from their studies that by 8 months of age, having seen but not touched two objects, if one is put unseen into the infant's hand and he is allowed to feel it, then when shown the two objects again the infant can choose which of the two he felt. The objects in this experiment were very similar, e.g. an allipsoid and an ellipsoid with a small cut-out, and so the infant's representation of the object must have been rather abstract, "rounded with a piece cut out" (Bower and Wishart, 1978).

As an example of the move from abstract to specific representation in cognitive development, Bower describes an experiment on object permanence task performance in young infants (Bower, 1977a). Two groups of infants were exposed to a tracking situation for different periods of time before being tested on the standard Stage IV object permanence task. The infants watched an object move along a track, enter a tunnel and then reappear at the other end of the tunnel. The infant's first discovery, according to Bower, is that the object can go into the tunnel and still continue to exist. If at this point he is transferred to the object permanence task he will succeed with this task sooner than control infants do. Infants given longer practice with the tracking before transfer also succeed with the object permanence tasks earlier than do controls, but not as quickly as those infants given less tracking practice.

Bower proposes that the infants given longer practice had specified

the original abstract description, into a rule of the form "to see an object that has vanished at the left hand edge of the tunnel, look for it at the right hand edge after x seconds". Bower suggests that the infants given longer practice can only solve the problem by "dredging from memory" the earlier, more abstract representation of the task.

Bower suggests that the explanation for the seeming repetition of earlier attainments given above applies to other repetitions in infancy and childhood (Bower, 1977a). These repetitions occur when older children give incorrect verbal answers to problems which younger children can answer correctly (Mehler and Bever, 1967; Maratsos, 1973).

"When the verbal tests are first given, there has not been enough time for the initial discovery to have been specified to the extent that the child is incapable of applying the discovery to other situations. With older children however, the initial discovery has been made highly specific. The relation between the initial problem and the new problem is therefore obscured" (Bower, 1978).

Again, the original discovery must be retrieved from memory.

To sum up, then, Bower believes that infants are capable of representing events, in the first sense of representation I employed. These representations are at first abstract, and with increasing differentiation in development become more literal, more specific. Representation in the second sense Bower discusses in the context of the acquisition of word meaning (Bower, 1978). In the growth of word meaning Bower argues that perceptual representations are made public. Those which are made public are those demanded by the child's particular communicational milieu. Word use will in addition reflect the specificity of perceptual representation achieved. Given the requisite environmental information then it would seem that for Bower representation in this second sense is achieved in language.

Summary of these theories of representation.

The three theories outlined above are contradictory on the question of representation in infancy. While Piaget does not believe that the infant can represent in infancy, Bruner and Bower believe that he can. Bruner believes that representation through action is the only available mode. Bower, however, proposes that since infants can perceive from birth they can form abstract representations from birth.

In the period after sensori-motor development Piaget considers that representation is achieved through the formation of images. Bruner agrees with this position, but seems to place the beginning of iconic representation earlier than Piaget does, at around 12 months of age. Bower sees all development in representation as a process of differentiation of the original abstract representations.

The emergence of the symbolic function antedates the acquisition of language for Piaget. Bruner considers that symbolic representation is not achieved until mastery of language is well advanced. For Bower, language would seem to be simply another specification, where representation becomes public instead of private.

Criticism of these theories, and additional experimental evidence.

E.J. Gibson (1969) has alleged that Piaget's contention that the image follows the act of interiorised imitation poses logical problems. Bruner believes that Piaget's theoretical account of the separation of action and percept is not explanatory (Bruner, 1966b). Cohen and Gelber (1975) claim that there is little experimental evidence to support Bruner's contention that the infant can represent events in action. Caron et al. (1977) interpret their results, which Bower adduces as evidence of non-iconic representation, as indicating that infants respond not to real

shape and slant but to the differential motion parallax of retinal disparity cues common to the slanted stimuli. Bryant et al's experiment cannot I believe be adduced as evidence of non-iconic representation, since the infants saw the objects before being allowed to feel them. They may have retained an iconic image of the seen objects which allowed them to recognise the felt object.

Experimental evidence can be presented that infants may be capable of representing events other than through action.

Bower (1966) showed that infants as young as six weeks of age anticipated the reappearance of an object when another was slowly moved over to occlude and then disocclude it. Heart rate measures of surprise were used. Infants were more surprised by reappearance than non-reappearance if the occlusion time extended beyond a few seconds. This result indicates that the infants were storing some representation of the object, whether iconic or non-iconic.

The multitude of habituation studies conducted successfully with very young infants would imply some representation of previous experience. Since it is a decrease in the amount of looking behaviour which indicates that information has been stored it would be difficult to interpret this as enactive representation (Cohen and Gelber, 1975).

That any such representation possible is quite specific by the age of 3 - 4 months is apparent from studies reported by Saayman et al. (1964) and Cohen et al. (1971). Using habituation paradigms they found that infants could store information as to form and colour of simple stimuli. Recovery was greatest when both dimensions were altered, however, so representation was not necessarily iconic.

Operant conditioning experiments also demonstrate some evidence of representation. If an infant learns to turn his head to obtain rein-

forcement then over the succeeding trials the infant will tend to repeat that response (e.g. Lipsitt and Siqueland, 1966). It is not clear what the representation of the response is, however. While Piaget might claim it to be an instance of a "device to make interesting things seen continue" (Piaget, 1945/62), Bruner would probably claim it as an instance of enactive representation, and Bower as a specification of an originally abstract conception of the connection between head movement and reinforcement.

Difficulties of interpretation of particular experimental results are obvious. However, it would be generally agreed that infant imitation involves representation of the model's act. I will now consider theories of imitation.

CHAPTER 2THEORIES OF IMITATION

The term "imitation" is used to describe a range of extremely diverse behaviours. There is no consensus on the nature of the processes assumed to underlie these heterogeneous behaviours. A chimpanzee attempting to put lipstick on its mouth, a child kicking dolls after seeing a film of another child doing so, an infant waving bye-bye, a man impersonating a goldfish - all these are examples of imitation, and there is no unitary theory to account for them all.

Imitation is usually defined as the act by which a model's action is reproduced. As Gilmore (1967) has indicated, a theory of imitation must be able to answer two fundamental questions. (1) how is an imitative act performed? (2) how does a new response come to be imitatively acquired?

IMITATION AS AN INSTINCTIVE TENDENCY

"Imitation is natural to man from childhood, one of his advantages over the lower animals being this, that he is the most imitative creature in the world, and learns at first by imitation" (Aristotle : De Poetica)."

Aristotle's view of imitation as an innate tendency prevailed until the beginning of the twentieth century, when the doctrine of instinct fell into disrepute. McDougall (1908) seems to have been the last psychologist to propound this view; he believed imitation to be a social facilitator. Valentine (1930) distinguished two kinds of imitation to circumvent the objection that a general tendency to imitate would lead to innumerable daily instances of imitation. The first was an instinctive tendency to imitate; the second "purposive imitation", i.e. imitation of a means, understood as a means, and presumably therefore

deliberate.

LEARNING THEORIES OF IMITATION

As Parton (1976) has indicated, there are three main learning theories of the genesis of imitation.

The first, and oldest, is the associationist view, which holds that the contiguity between seeing a model and by chance producing the same response is sufficient for response iteration. (Allport, 1924; Maccoby 1959).

The second is the discriminative learning view, which holds that by chance a response similar to the one the model produced will be produced and then reinforced. The probability of it re-occurring to that stimulus will, therefore, be increased. The similarity between the stimulus model's action and the response is merely fortuitous; any other response could be reinforced with equal efficacy (Skinner, 1953).

The third is the conditioned reinforcement view, a variant of the discriminative learning view. Imitation is established by chance reproduction of the model's stimulus, but the primary reinforcement by the model is superseded by the secondary reinforcement of making the match.

The associationist viewpoint has been criticised by Piaget (1945/62), who argued that haphazard contiguities would lead to all sorts of haphazard associations, which have not in fact been observed. Parton (1976) has pointed out that if such contiguities were haphazard they would not lead to associative strength between stimuli and mismatch because they were likely to be infrequent. However, the question of how the infant acquires novel responses not in his repertoire still remains unanswered

by this theory (Bandura, 1969).

The discriminative learning view has been criticised on the grounds that it cannot account for instances where imitation is not reinforced by the adult, as in observational learning (Bandura and Walters, 1963). In addition, Piaget (1945/62) has shown that such reinforcement training is generally ineffective.

The conditioned reinforcement view can be criticised on the grounds of inadequacy of explanation of the infant's ability to detect similarity between his action and the stimulus. Bandura (1969) has also criticised this theory on the grounds that imitation would be much more widespread than it is if it were correct, of numerous models on numberless occasions.

PIAGET'S THEORY OF IMITATION

Piaget views imitation as a phenomenon which itself develops, and his theory explicitly ^{rejects} learning models for the origin of imitation. His is the only theory of imitation which is supported by observations of infants, and is therefore the most important contribution to this field.

Piaget defines imitation as "the act by which a model is reproduced", and believes that no ability to represent the model is implied, since it may simply be "perceived". (Piaget 1945/62). Piaget found that the development of imitation paralleled the six stages in the growth of intelligence he described earlier (Piaget 1936/53). Two conditions must be met, according to Piaget, before imitation can occur. The first is that the schemas must be capable of differentiation when confronted with the data of experience; the second, the model's behaviour must be analagous to the results the infant has itself obtained, i.e. the model

must be assimilated to a circular schema he has already acquired. Thus, Piaget would not expect an infant to be capable of imitation until the third stage of sensori-motor development, that of secondary circular reactions.

In fact, it is not until that stage that Piaget finds evidence of imitation; but because of the historical emphasis on the innatism of imitation, he studied imitation from birth. The six stages he described are as follows:-

Stage I "Preparation through the reflex" (0 - 1 month)

Piaget found no evidence of imitation at this stage. His son, awakened at night on the day he had been born, began to cry when he heard other infants cry; but Piaget believed this to be the mere starting of a reflex by an external stimulus. Either the infant was unpleasantly affected by being woken, and so began to cry, or the crying resulted from its repetition, with the infant confusing others' cries with his own.

Stage II "Sporadic imitations" (1 - 4 months)

During this stage reflex schemas are broadened by the incorporation of external elements as a result of experience. Reflex crying is broadened into differentiated vocalisation for its own sake; the first visual accommodations to moving objects are made. Piaget finds evidence of the beginnings of imitation in phonation and vision. Occasionally, from the age of one month, his son would vocalise after Piaget had made some sound, without any attempt at differentiation, - "vocal contagion". He would also reproduce sounds he had just made when Piaget imitated him (mutual imitation); and at 2 and a half months the infant imitated sounds which were in his repertoire, but which he had not been heard to make immediately prior to the experiment. The

infant only kept up this behaviour for a fortnight, after which time only the "vocal contagion" and "mutual imitation" could be elicited. This behaviour, true imitation, Piaget also observed once in one of his daughters. This was, therefore, very exceptional, and the infants never tried to imitate new sounds they could not themselves make.

In vision, too, some evidence of the beginning of imitation can be found at this stage. At two and a half months of age, his daughter clearly imitated an up-and-down movement of Piaget's head and then a side-to-side movement. As for prehension, at three months of age, his son clearly imitated his father's action when he separated and then brought together his hands.

Piaget explains these instances of sporadic imitation as simply continuation of movements of accommodation, when these are part of an already formed circular reaction or of a general assimilatory activity. When a child hears others making a sound, he attempts to have it repeated, and because accommodation to the sounds is inseparable from the schema of assimilation already formed, hearing the sound at once sets the schema in motion. In the case of the head movements, exactly the same obtains. In order to continue to see the other person's head moving, all the child has to do is reproduce his own movements of accommodation. As soon as the infant moves his own head, the other person's head seems to be moving again. Similarly, in the case of prehension, the infant, in watching his hands move accommodated his eyes to the movement and assimilated that movement to a familiar schema (moving his own hands together and apart). There is nothing mysterious about this, according to Piaget. It is an example of cognitive assimilation, which is indissociable from reproductive assimilation at this stage. The child neither confuses the adults' body parts with his own, nor does he necessarily distinguish them from his own. There can not, therefore,

be any imitation of new actions at this stage.

Stage III "Systematic imitation" (4 - 8 months)

New models can be assimilated at this stage, but because the secondary reactions are not co-ordinated one with the other, there can be no accommodation to new models. Thus his infants would imitate almost all the sounds they made spontaneously. The mechanism is the same as that utilised in Stage II; the intention is to prolong interesting events. During this stage, they would also imitate hand movements for which they had schemas, but specific movements which had not been isolated from the schemas in which they occurred were no better imitated than entirely new movements. Thus, movements of grasping and of the fingers were imitated, but opening and closing the hand was not imitated until the child herself had isolated this component of another schema and practised it herself. That there is no spontaneous imitation of movements the infant cannot see himself make is apparent, according to Piaget, from the observation that his infants would not between 5 and 8 months imitate mouth movements (protruding the tongue, opening the mouth, etc), except in specific situations. One of these is the case of pseudo-imitation, where an action may be imitated in a specific situation of "mutual imitation", i.e. the adult imitates the infant, and the infant repeats his actions in order to reproduce this interesting event. Such imitation tends not to last, unless it is strengthened by a "continual show of approval" when it may persist until assimilation begins with the progress of intelligence.

Stage IV "Imitation of movements already made by the child but which are not visible to him (8 - 12 months)

This stage of sensori-motor development is characterised in Piaget's theory as being that at which schemas begin to co-ordinate

with each other, producing a system of "indices" relatively detached from actual perception. In addition, the global relationships between the secondary circular reactions concerning space, objects and causality give way to the elaboration of relationships between things. The first development enables the child to assimilate the movements of others' bodies to his own body, even when he cannot see his own movements. The second facilitates accommodation to new models. Thus at 8 months his daughter imitated lip movements and tongue protrusion, movements she had not been seen to make before the observations began, and which of course she could not see herself make. During this stage Piaget observed his children touching the finger to the nose, eyes and ears, putting a finger in the mouth, opening and shutting the eyes. That training was required for this systematic imitation of movements by parts unseen he adduces from his observations of the errors his infants made in their attempts to imitate - opening and closing the hands instead of the mouth, for example - and from the great attention the infants gave to the task. This training seems partly to have consisted in Piaget imitating the child - "mutual imitation". The question of "meaningfulness" arises here. Piaget concludes there is no justification for the idea that imitation begins with meaningful and significant movements and is later transferred to meaningless movements; his evidence is that the movements his infants imitated first were meaningless, e.g. putting a finger in the mouth, and only later did they imitate meaningful movements of the same organs, e.g. putting a spoon to the mouth. The reason for the order of attainment is found in the mechanism of the spontaneous schemas. Imitation begins with movements that are ends in themselves, and is only later applied to movements integrated in those schemas, and so the pace of imitation is bound up

in the schemas, and differentiates along with them.

Since accommodation to a new model requires a flexibility of schemas dependent on their co-ordination, and as mentioned above the fourth stage of sensori-motor development sees the elaboration of co-ordinations between schemas, it is not surprising that it is during this stage that infants become capable of imitating new movements. Accommodation is beginning to be differentiated from assimilation. Piaget found that at eight months of age his children were able to imitate new sounds, a "marionette" movement of the wrist, hitting a duck with a comb, etc. However, they were unable to imitate entirely new movements made without being seen. At this stage they are capable only of the application of known means to new situations, and of further investigation.

Stage V Systematic imitation of new models including those involving movements invisible to the child (12 - 18 months)

During this stage of sensori-motor development the child moves from mere investigation of objects to active experimentation. His imitation then becomes exact. Because accommodation and assimilation are now differentiated the child can go beyond the accommodation of existing schemas to accommodation through systematic trial and error. Thus, after the age of 12 months Piaget observed imitation of drawing, putting on a bracelet, imitation of adult words through gradually closer approximations, ^{of} putting a hand to the hair, touching the chin (by gradually working the hand down from the mouth). The elements of the schemas are now differentiated, and so the child can systematically work through these and make invisible movements.

Stage VI. Beginnings of representative imitation and the further development of imitation (18 - 24 months)

The culmination of the development of imitation is this final stage, where the accommodation is interiorised and the child need no longer experiment; he can imitate a new act immediately. Imitation is no longer dependent on the actual model, but may be "deferred", i.e. it takes place in the absence of the model, presumably in response to some sort of representation of the model, or it may occur to an actual representation, an image. Representation is also apparent in children's imitation of material objects. Thus Piaget noted during this stage immediate imitation of a very complex arm movement; deferred imitation, in one instance of behaviour seen in another child twelve hours previously and in the other of an illustration of a child with his mouth open; and imitating with the mouth a material object, a matchbox.

Problems of interpretation of Piaget's theory

Monumental though the task, and meticulous the observation, Piaget's theory of imitation seems to concentrate more on the drawing of parallels between the development of different aspects of intelligence, and the description of the means by which representation as a mental memory image might come about, than on the phenomenon itself. The result is that certain difficulties of interpretation arise. The first problem is the issue of training in imitation. While on the one hand Piaget believes that early imitation can be elicited by "the pedagogical mania of nurses", on the other hand, for later imitation of movements the child cannot see himself make, training, which partly consists in "mutual imitation", is necessary. But the former case Piaget labels

"pseudo-imitation", maintaining that only under the influence of continual stimulation can it persist, as, e.g. smiling does. Piaget claims this to be an instance of "non-intentional convergence between the action of the model and that of the subject" (Piaget 1945/62). The later imitation through training he considers true imitation, because the model is assimilated via intelligent indices to the child's own activity. Now, if the only difference between pseudo-imitation and true imitation is that the former does not persist, while the latter does, he has himself provided an instance where this is not the case. It was the errors in production which led him to believe that the later imitation was true imitation, and yet if the former is not true imitation, then error should also be apparent there. If the infant is unaware of the convergence between his action and that of the model, why should he be able to repeat that action, and not produce a different one.

Another problem arises with Piaget's conception of familiarity. Infants are not able on his theory to imitate actions for which they do not already have schemas. Obviously then in any instance of non-imitation it could be argued that that particular infant had not spontaneously practised the required schema. The difficulty any investigator might have in determining the familiarity of a particular act for a particular child would be extreme. It is to the point that Piaget himself classified similar actions in one of his daughters.

In one instance as imitation of a simple secondary circular reaction and later as imitation of a new model. Thus hitting a soap dish with a brush (Piaget, 1945/62 obs. 15) it occurs in Stage III of imitative development while hitting a duck with a comb (Piaget, 1945/62 obs. 36) occurs in Stage IV of imitative development.

Parton (1976) considers there to be a difficulty with Piaget's belief that the infant must associate the visual perception of other's mouths and the tactilo-kinesthetic perception of his own mouth before he can imitate. The infant must make the response before the association can be formed; if factors other than kinesthetic feedback account for this first response, then they might also account for what seems to be subsequent imitation.

Although there are problems of interpretation with Piaget's Theory of the development of representation through imitation, subsequent research has substantiated his description of the development of imitative ability itself. Thus Paraskevopolous and Hunt (1971) and Uzgiris 1972 reported broad similarities between Piaget's description of this development and their own findings from longitudinal and cross-sectional studies. However, in neither of these studies were infants younger than one month used as subjects.

Piaget's description of the development of imitation is the only longitudinal study available; although issue may be taken on particular points, the development of the imitation of particular acts he describes has been substantiated by other research. (Paraskevopolous and Hunt 1971; Uzgiris, 1972).

CHAPTER 3EXPERIMENTAL RATIONALE

Piaget's theory of the development of representation through imitation is the only major theory of this development with strong evidence to support it, at least after the age of four months (Paraskevopolous and Hunt, 1971; Uzgiris 1972). The theory allows for direct experimentation, and clear predictions can be made.

(1) Very young infants, (0 - 3months of age), incapable of representation or thought, in whom co-ordination of the senses has not developed, will be incapable of imitation of bodily movements even when these are already in their repertoire of bodily movement.

(2) Older infants (6 - 10 months of age) who can only represent objects or movements by performing the familiar actions appropriate to them, will be incapable of imitation of novel movements, even when these movements naturally occur as part of other schemas.

(3) Children (18 - 24 months of age) who are capable of imitating novel acts immediately and are therefore capable of forming and acting on the basis of images will be able to act upon information supplied by representations, whether pictorial or literal.

It was to a test of these three predictions that the experiments I shall describe first were applied. Experiments I - IV were designed to test the first prediction, that young infants cannot imitate actions already in their motor repertoires. Experiment V was designed to test the second prediction, that older infants cannot imitate novel movements. Experiments VI and VIII were designed to test the third prediction, that children should be able to act on the basis of pictorial or literal representations.

Bruner's theory would not allow for imitation in very young or even slightly older infants, since he agrees with Piaget that representation through action is all that is available to the infant in the first year of life. Bruner would agree with Piaget that by the age of 18 - 24 months the child is capable of "knowing something though a picture of it" - iconic representation (Bruner 1966).

Bower's theory would not allow for accurate imitation in young infants; since he argues that higher levels of abstraction precede and indeed generate the lower levels (Bower 1978), it is difficult to see how young infants would be able to produce specific and precise imitation of a model. However, his theory would allow for representation to have become specific enough to allow for action on the basis of a pictorial or literal representation.

Experiments I - IV

These experiments were designed to investigate the possibility of early infant imitation. Modern techniques of videotaping allow for precise recording of model and subject movements, and the assessment of any relationship between these. The comparison of several infants of differing ages under the same experimental circumstances permits study of any development in ability.

Piaget's contention that young infants are incapable of imitation is in any case not in accord with some other reports, although these were mostly early, and anecdotal in nature. However, Piaget himself noted that there were puzzling instances of imitation for which he did not offer an explanation (1945/62). More recent research, unfortunately of only a single infant, (Gardner and Gardner, 1970) does indicate that imitation is present to a limited extent in six week old infants. I consider the findings on imitation reported for particular acts below.

Mouth behaviours

Piaget found that tongue protrusion and mouth opening could not be imitated until the age of 8 - 12 months. However, Valentine believed he saw imitation of mouth opening at 2 weeks of age (1930). Zazzo found evidence of tongue protrusion at 28 days (1959) and Guillaume (1926/71) quotes Scupin (1907) as finding tongue protrusion at 11 weeks. Guillaume dismisses this as a form of selection of behaviours of the sort often used by animal trainers, by which I believe he meant operant conditioning. The similarity between stimulus and response was merely fortuitous. Gardner and Gardner (1970) noted mouth opening and tongue protrusion in imitation in an infant aged six weeks.

Uzgiris (1972) has reported some imitation of mouth movement in 10 week old infants to a "cchoing" model.

Head Behaviours

Piaget found imitation of head nodding and shaking at seven weeks of age. His explanation of this seeming imitation was that the infant in attempting to follow the movements of the model was forced to make slight head movements herself, and thus in order to make the interesting event (the model's head moving) re-occur, need only reproduce her own movements. In the first place, one wonders how far Piaget's head was moving, since eye movements alone would have been sufficient for the infant to follow a slight movement at that age, and he did not observe head movements prior to all instances of imitation. In the second place, the infant would not have been able to re-create the interesting event, since the whole stimulus array would move, not just Piaget's head. In the third place, why should the child have been so particular about which interesting event she wanted repeated, and move her head appropriately (i.e. up and down or side to side) as the model did? Piaget found the same response to toys; he concluded that visually perceived movement was being

"imitated" and not head movements per se.

Valentine (1930) found that this movement could not be imitated until 12 months of age.

Hand Behaviours

Piaget observed moving of the fingers in imitation at 6 months (Piaget 1945, 1962 obs. 13). However, Bower (1971 pers. comm.) indicated that a student of his, K. Moore, had found evidence of imitation of hand movements in neonates. Gardner and Gardner (1970) found some evidence of hand opening and closing at six weeks of age.

Design of experiments on imitation in young infants.

The design of experiments to study imitation posed problems. If an infant once imitated a model it might simply be the case that he was responding in a particular way to that stimulus, either because that stimulus was some sort of innate releaser of that response, or because he had himself recently made a similar movement. If the infant continued to imitate the model, it might be true that this behaviour was being shaped by the reinforcement of seeing the original stimulus repeated. If the infant did not continue to imitate he might be showing pseudo - and not true imitation.

It was decided then in view of these problems that the frequency of infant's imitative behaviour in the presence of one model would be compared with the frequency of the same behaviour in the presence of a different model. If one type of movement occurred more often when that same movement was being modelled than when another movement was being modelled, then imitation might fairly be said to have taken place. It would be unlikely that innate releasing mechanisms could be at work in the imitation of a number of movements without this having become obvious to the many investigators in this field.

Secondly, there should be a short period before the model began to act during which the infant should not be seen to make any of the movements the model is about to demonstrate. This period can not be considered a baseline for subsequent behaviour for the following reasons.

The motor capacities of young infants are extremely limited. Any movement to be imitated must of necessity be possible for them to make, and it is therefore likely to occur spontaneously during the experiment. An adequate baseline measure is thus wellnigh impossible. If, for example, human mouth movements are to be modelled no useful purpose can be served by presenting an infant with his mother when he has been staring at a blank wall. The arousal effect of such a stimulus might well be sufficient to produce similar mouth movements. Nor, on the other hand, would I consider the presentation of a still, unsmiling mother an adequate baseline measure; tongue protrusion, for example, has been used as an index of infant distress (Aronson and Rosenbloom 1973) and such an extraordinary sight might well prove distressing. Stern (1974) and Trevarthen (1975) have both noted infant distress when an unmoving mother's face was presented. A stranger's face during a baseline period might predispose an infant to make a particular response; a mother's smiling and talking-face presentation during baseline might cause the infant to become fractious when at my request she began to make some other movement. The use of a period before modelling begins during which the to-be-modelled behaviour is not observed does reduce the possibility of the model inadvertently repeating the child's own act and thus obtaining a seeming imitation, but it cannot be considered a baseline.

Thirdly, to avoid the possibility of the model shaping the infant's

response, the mother was chosen as the model in the experiments involving human imitation. If the mother was unaware of the purpose of the experiment she was unlikely to be able to influence the infant's behaviour significantly. In any case, a stranger is not so often imitated as is a familiar person, (Valentine 1930) even from the youngest months, according to Piaget (1945/1962).

Fourthly, to avoid pseudo-imitation, the imitation must be repeated on another occasion of testing.

Fifthly, the infants' behaviour must be assessed by an observer unaware of the action being modelled to the child. Piaget's objective appraisal of infant imitative ability may not have been emulated in older studies, leading their authors to perceive imitation where there was none. We know that adults are likely to ascribe intention to the most insignificant of infant behaviours (MacFarlane 1977, Newson 1977); knowledge of the action being modelled would undoubtedly influence the collation of results.

Sixthly, As far as possible, I tried to avoid contamination of results by the errors Piaget describes (1945/62 obs. 28 - 31) as taking place when the infant assimilates the model to an analagous schema instead of to the correct one; e.g. when Piaget opened and closed his eyes, the infants opened and closed their mouths or hands. I did not present similar movements of different organs as models in the same experiments. If the model were to open and close the mouth, the infant might make the error of opening and closing the eyes; if the model changed to opening and closing the eyes there might be an increase in the frequency of the infant's opening and closing of the eyes, because he had performed that action immediately prior to the

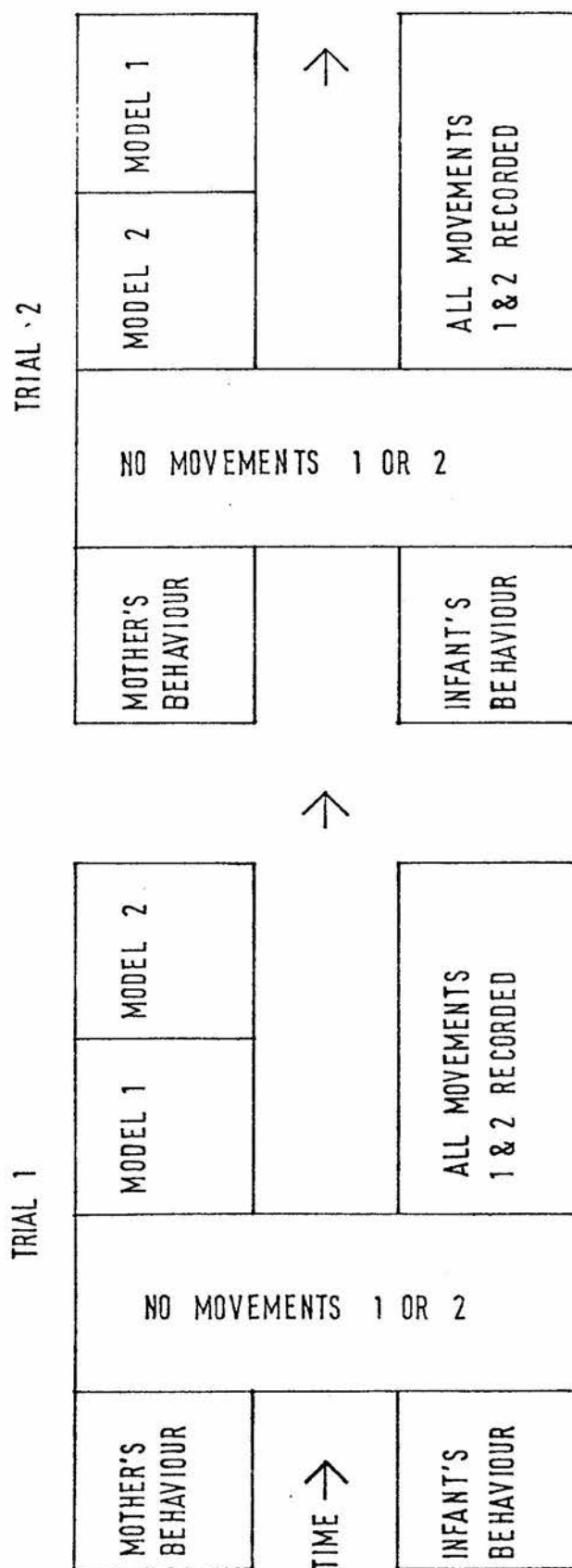


FIGURE 1 : DESIGN OF EXPERIMENTS ON
EARLY INFANT IMITATION

presentation of the model. This result would read to a false judgement of ability to imitate the model of opening and closing the eyes. Alternatively, the infant might actually imitate opening and closing the eyes, but at the same frequency as when mouth opening was presented, where there the opening and closing of the eyes was not imitation. This would lead to a false judgement of inability to imitate the model.

Behaviours to be studied

I considered that mouth opening, tongue protrusion, head nodding, head shaking, toy movement and finger movement were obvious models with which to present young infants, given the contradictory evidence as to the possibility of these models being imitated.

In addition, I decided to present arm movement and eye movement models. Piaget (1945/62) found that arm movements could not be imitated until around 10 months of age; but Bower et al. (1970a) found that neonates could make directed arm movements to an object. There seems no reason then why they should not be able to touch their own faces in imitation. Piaget (1945/62) found that mouth and eye movements are imitated successfully in the same period of imitative development, at 10 - 11 months of age. I have referred above to evidence that very young infants can imitate mouth movements; I decided therefore to present an eye closing model on the assumption that imitation of this model should be no more difficult than of mouth movement.

The general design of the young infant imitation experiments is shown in Figure 1. Some modification was necessary in Experiment I, where three models were presented, and in Experiment IV, where the observation period was altered. These changes in design will be discussed in the descriptions of those experiments.

The models used in Experiments I - IV are laid out below.

Experiment I Shaking the head; toy movement; tongue protrusion.

Experiment II Nodding the head; tongue protrusion.

Experiment III Opening and closing the mouth; finger movement.

Experiment IV Arm movement; opening and closing the eyes.

CHAPTER 4

EXPERIMENT I

Head turning in imitation of mother and of toy; tongue protrusion in imitation of mother.

The purpose of this experiment was to attempt to replicate Piaget's finding (1945/1962 obs. 5 and 6), that infants of about 7 - 12 weeks would turn their heads after seeing their father do so, or after seeing a toy move, and to confirm reports of tongue protrusion in imitation at ages younger than twelve weeks (Guillaume, 1926: Zazzo 1959: Gardner and Gardner, 1970).

METHOD

Subjects - 4 boys and 4 girls, aged 4 - 13 weeks, of whom seven completed both parts of the experiment (mean age on first visit 66.4 days, s.d. 26.1 days). All were full-term, normal, healthy, infants. Two other female infants could not be used because of continuous crying.

Apparatus - The toy used was a green and red bird, approx. 4" x 3" x 3", which had been found to be an attractive object to infants in this age range.

Modelled behaviours.

1. The moving toy. Out of sight behind the infant's head, I moved the toy from approximately 40 cm. directly above the infant's head slowly to his right (or left) back to centre, and then to the left (or right) and back to centre when the infant was fixating the toy, for five minutes.
2. Shaking the head. The mother, when the infant was looking at her, moved her head slowly to one side, then the other, to the first side again, and again to the other, the whole movement taking about 5 seconds.

She was then to look at the infant. Mothers spontaneously varied the side to which they turned first. After a short interval, if the infant were still watching her, she was to repeat the movement. This condition also lasted for five minutes.

3. Protruding the tongue. The mother, when the infant was watching her, was to protrude her tongue slowly and then retract it, and repeat this after a short interval. This movement was about three seconds in total duration, and the condition was five minutes long.

Procedure

The infants lay on a bed above which was mounted a Shibaden HV 16S camera recording the full face image of the infant's head on to a Sony CV2100 ACE VTR. Infants were supported by firm pillows to allow free head movement. When present, the mother was seated beside the infant with her face approximately 45 cm. from his. Her behaviour was recorded by another video camera behind the infant. Mixed through an Effects Generator these camera inputs produced a split-screen image with the mother on one side and the infant on the other.

Instructions to mother/observation period

While explaining the experiment to the mother, who was either sitting beside the child or looking at the monitor, I watched the monitor to check that the child did not protrude his tongue or shake his head before the experiment began for a period of at least one minute. Mothers were informed that I was interested in "baby's reactions to moving faces and objects".

The three conditions were repeated on two occasions, separated by approximately one week. The third condition was always the last, but the first two were counterbalanced for order with half the infants starting with condition 1 and the other half with condition 2 (reversed

for each infant on the subsequent occasion). The total experimental period was thus thirty two minutes.

Should any mother during this experiment (or any of the following ones) express the opinion that her infant was imitating her, I said this was probably coincidental. Mothers were asked not to practise their infants by repeating any of the movements in the week between tests; and by and large they seemed not to have done so. At the end of the second trial I explained the true nature of the experiment, and this usually came as a complete surprise to the mothers, most of whom, following the advice given them by doctors, health visitors etc., believed their infants to be far from sentient beings at this age and incapable of imitation.

RESULTS

Scoring of data

An observer scored the tapes blindly, first for head shaking and then for tongue protrusion. In this and in all the subsequent infant imitation studies the observer was unaware of the true purpose of the study; he did not know how many models were being presented, nor what they were. Occasionally, I asked him if he could guess which model was being presented and he was nearly always wrong (he was not informed of this fact). He could see only the infant's image, the mother's image being blaked off on the monitor he watched. I watched another monitor and recorded the time of occurrence of the movements.*

* Since the VTR would not be stopped without loss of precision in the timing, each experimental session for each infant had to be viewed many times over. The observer did not score for the two movements simultaneously; often he would express the desire to see particular segments again, to check on his judgement. As there was therefore at least 8 hours of tape to be scored in this experiment alone it will be appreciated that analysis took months.

Head shaking was categorised in the following way. If the infant's head turned to the side through approximately 10° , so that the edge of his eye lined up with the pillow, and then turned back to the midline, half a turn was counted. A full turn was the edge of one eye lined up with the pillow and then the edge of the other eye lined up with the other side of the pillow and then a turn back to the midline.

The criteria for tongue protrusion were more stringent. The infant's tongue must be seen to pass over the lower lip and actually protrude from the mouth. Pushing the tongue behind or on top of the lip was not counted, nor were movements of the tongue inside the mouth. Tongue protrusions when the hand or finger was touching the mouth were also not counted.

Results of data collection

Analysis of a random sample of tapes of eight trials showed that in these the mean number of times the models were presented was as follows;

Model 1 (Toy) 11.5 (s.d. 2.65)

Model 2 (Head shaking) 10.25 (s.d. 2.87) and

Model 3 (Tongue protrusion) 28.5 (s.d. 10.72)

Obviously the number of times a model was presented depended on the amount of times the infant watched the model and on individual variation between models.

The number of head turns made by the infants to the shaking human head, movement of the toy and tongue protrusion models are shown in Table 1.

TABLE 1

Number of infant head turns in the three conditions.

<u>Subjects by age</u> <u>in weeks and</u> <u>days</u>		1st trial			2nd trial		
		<u>Model</u>			<u>Model</u>		
		Head turn	Toy	Tongue Protrusion	Head turn	Toy	Tongue Protrusion
1	4.6	0	1	$\frac{1}{2}$	-	-	-
2	5.3	0	0	0	0	0	0
3	6.1	0	0	0	0	0	0
4	8.1	0	0	0	0	0	0
5	12.5	$\frac{1}{2}$	0	0	0	0	0
6	12.5	0	0	0	0	0	0x
7	12.6	3	0	1	$\frac{1}{2}$	0	$\frac{1}{2}$
8	13.1	$\frac{1}{2}$ [*]	0	$\frac{1}{2}$	0	$\frac{1}{2}$	0
Total		4	1	2	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
Mean		0.5	0.12	0.25	0.07	0.07	0.07
s.d.		1.1	0.35	0.38	0.18	0.18	0.18
* severe crying							

Results for both trials summed.

Model

	Head turn	Toy	Tongue protrusion
Total	4.5	1.5	2.5
Mean	0.31	0.1	0.17
s.d.	0.75	0.28	0.31

t-tests for differences between correlated pairs of means was carried out on the total number of head turns in both sessions. The number of head turns infants made when the mother was shaking her head was not significantly different from when the toy was being moved (7 df. $t = 0.93$, n.s.) nor from when she was protruding her tongue (df. = 7, $t = 1.31$, n.s.). The null hypothesis, that there would be no difference in amount of head shaking by the infants in the three conditions, must therefore be upheld.

As is clear from the Table, there were very few movements of the head, either to the mother's model or the toy; on the one occasion when a child seemed to be imitating (infant no. 7, first visit), the video record showed that the child was extremely inattentive, kicking her legs, looking around, etc., during the modelling period. One infant, (no. 8) began to cry 20 seconds after his mother began to shake her head on the first session, and continued to do so throughout the condition, sticking his tongue out as he did so. Another infant (no. 6) cried in earnest half way through her second session (3rd condition).

In general it may be remarked that the infants became extremely bored with both the mother shaking her head and with the movement of the toy. Although at first infants would follow these movements with both eyes and slight head movements, by the end of these conditions some of the infants were hardly attending at all.

Tongue protrusion.

Table 2 shows the frequency of tongue protrusion during the three conditions. No order effects were evident in the efficacy of the first and second models shown to each infant in eliciting tongue protrusion. 55% of total response occurred in the first model presented. It may be recalled that infant No. 6 (2nd session 3rd condition) and

infant no. 8 (1st session 1st condition) were both crying quite severely throughout; although it was the case that all infant no. 6's tongue protrusions took place before she began to cry and that infant no. 8's mostly took place while his eyes were shut for extended periods.

TABLE 2

Number of infant tongue protrusions in the three conditions.

<u>Subjects by age in weeks and days</u>	1st trial			2nd trial		
	Head turn	Model Toy	Tongue Protrusion	Head turn	Model Toy	Tongue Protrusion
1. 4.6	0	0	0	-	-	-
2. 5.3	1	1	8	0	0	1
3. 6.1	0	2	2	4	0	8
4. 8.1	8	3	2	2	0	9
5. 12.5	2	0	25	3	1	7
6. 12.5	2	0	8	2	5	5*
7. 12.6	0	0	0	0	4	11
8. 13.1	12*	3	7	3	3	2
Total	27	9	52	14	13	43
Mean	3.125	1.13	6.5	2	1.86	6.14
s.d.	4.45	1.34	8.1	1.52	2.1	3.67

* crying severely

Results for both trials summed

	<u>Model</u>		
	<u>Head turn</u>	<u>Toy</u>	<u>Tongue Protrusion</u>
Total	41	22	95
Mean	2.6	1.47	6.33
s.d.	3.36	1.73	6.29

t-tests for differences between correlated pairs of means were carried out on the total number of tongue protrusions in both sessions. The number of tongue protrusions infants made when the mother was performing the same movement compared to the number each infant made when she was shaking her head was not significantly different ($df. = 7$, $t = 2.20$, n.s.) but was significantly different from when the toy was being moved ($df. = 7$, $t = 2.94$, $p < .05$). Comparing number of tongue protrusions on the first trial, the difference between the number of tongue protrusions when that was being modelled and head turning was being modelled was not significant ($df. = 7$, $t = 0.5$, n.s.) nor when the toy was being moved ($df. = 7$, $t = 1.73$ n.s.). However, both these differences were significant in the second trial; for frequency compared between head turning and tongue protrusion models ($df. = 6$, $t = 2.87$, $p < .05$) and for toy and tongue protrusion models ($df = 6$, $t = 2.72$, $p < .05$). No significant correlation between age and imitative ability was found (Spearman correlation coefficient $r = 0.13$).

In general most of the infants were attentive and happy during this condition, but by the end of it some were becoming restless.

Figure 2 shows the results of this experiment graphically.

DISCUSSION

This experiment failed to replicable Piaget's finding of head shaking in imitation, although several of the infants in the study did shake their

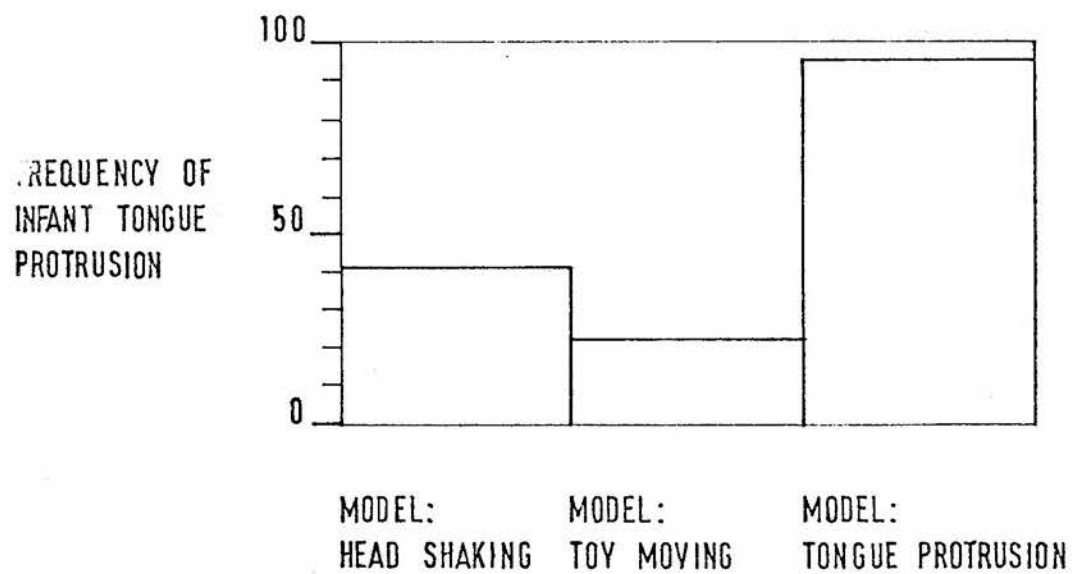
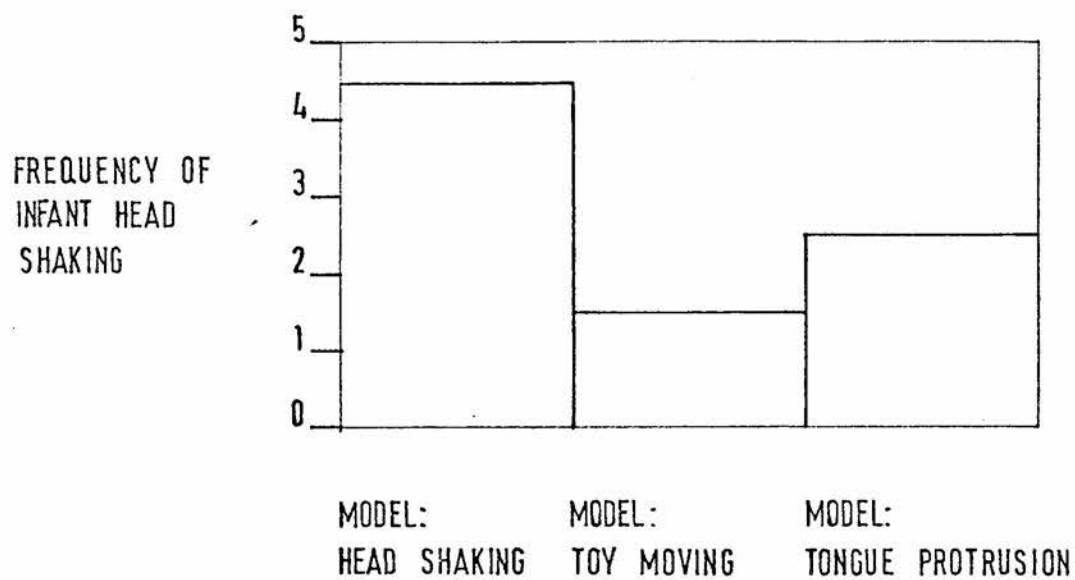


FIGURE 2 : RESULTS OF EXPERIMENT I

heads on occasion, and so were not incapable of doing so. It did replicate the reported findings by Guillaume, Zazzo and Gardner and Gardner on imitation of tongue protrusion to a limited extent; although the youngest infant to show this was over five weeks of age.

However, the procedure was too long, as shown by the number of infants who became distressed at some point; and it was therefore decided that since as time went by the infants were likely to be distressed and so to protrude the tongue, this part of Experiment I should be repeated. Experiment II attempted to replicate these results, and if possible, to find evidence that they did not merely "pseudo-imitation", as might be possible, since a significant difference between frequency in the different conditions was found only in the second session.

CHAPTER 5

EXPERIMENT II

Nodding the head in imitation of the mother and protruding the tongue in imitation of the mother.

The purpose of this experiment was to replicate Piaget's finding (1945/1962, obs. 5) that a 10 week old infant would imitate a nodding movement, and the findings in Experiment I on tongue protrusion in imitation described above.

METHOD

Subjects

Six infants, 3 boys and 3 girls, of ages ranging from 3 - 11 weeks (mean age 52 days; s.d. 19.4) served as subjects. All were full-term, normal, healthy infants.

Modelled behaviours

The tongue protrusion model was as described in Experiment I, with the mother as model. The nodding model, again the mother, slowly nodded her head up and down two or three times, and then stopped, in a manner similar to that described by Piaget. After a while, if the infant was still watching her, the model repeated this action, which took about 3 seconds.

Procedure

The procedure, instructions to mother and observation period were the same as in Experiment I. Each condition lasted for five minutes, and the first was followed immediately by the second condition. The experiment was repeated approximately 1 week later for all subjects, with order of presentation of conditions counterbalanced across subjects (and reversed for each subject on the second occasion of testing).

RESULTS

Scoring the data

An observer scored the tapes blindly for both head nodding and tongueprotrusion movements by the infant, separately. Any movement of the head in a downwards (or upwards) direction followed by an upwards (or downwards) movement was to be considered as a head nod. The criteria for tongue protrusion were as previously used in Experiment I.

Results of data collectionHead Nodding

The observer failed to report any head nods at all, although very infrequently movements either up or down were observed and so presumably the infants were capable of making this movement. This result was in accord with my own observations. This does not seem to be a typical behaviour for infants in Scotland, at least.

Tongue protrusion

Analysis of a random sample of tapes of eight trials showed that in these the mean number of times the nodding model was presented was 26.5 (s.d. 7.85) and the mean number of times the tongue protrusion model was presented was 34.5 (s.d. 6.76).

Table 3 shows the number of tongue protrusions by the infants which occurred in the two conditions.

TABLE 3

Number of infant tongue protrusions in the two conditions.

<u>Subjects by age in weeks and days</u>	<u>1st trial</u> <u>Model</u>		<u>2nd trial</u> <u>Model</u>	
	Nodding	Tongue Protrusion	Nodding	Tongue Protrusion
1. 3.2	7	19	4	18
2. 6.4	12	11	4	22
3. 6.4	3	13	2	7
4. 7.5	8	10	9	12
5. 9.6	2	5	4	8
6. 11.1	3	9	4	11
Total	35	67	27	78
Mean	5.83	11.17	4.5	13
d.d.	3.87	4.67	2.35	5.87

Results of both trials summed

	<u>Nodding</u>	<u>Tongue Protrusion</u>
Total	62	145
Mean	5.17	12.08
s.d.	3.13	5.14

The imitative performance of the younger infants (as assessed by the difference between the total number of tongue protrusions in the two conditions) was superior to that of the older infants (Spearman correlation coefficient between age and performance $r = 0.71$).

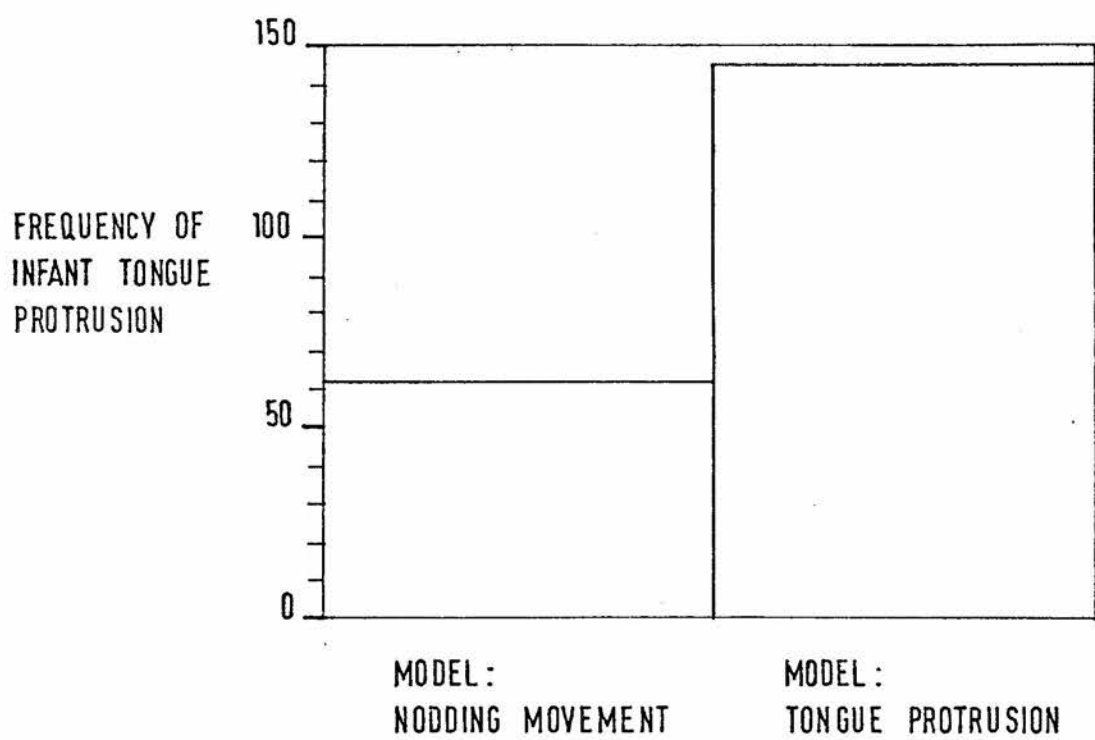


FIGURE 3.

t-tests for correlated pairs of means were carried out. When applied to the total number of tongue protrusions in the nodding and the tongue protrusion model conditions for each infant, the difference between these conditions was significant ($df = 5$, $t = 4.49$ $p < .01$). The difference between the number of tongue protrusions in the two conditions was significant both on the first trial ($df = 5$, $t = 2.63$, $p < .05$) and on the second ($df = 5$, $t = 3.63$, $p < .05$). The results of the analysis are shown graphically in Figure 3. No order effects were discernible; the frequency of total tongue protrusion to that model was 57.2% when it was presented as the first model.

In general the infants attended to the mother without fussing, and some infants watched the mother intently throughout. Many of them smiled when the mother made a movement. By the end of the experiment however some of the infants would not look at the mother.

DISCUSSION

The results of the experiment do not unfortunately replicate Piaget's finding with respect to head nodding. One reason why this may be so is the fact that the infants in this study were semi-reclining, while J. was upright in her mother's arms while Piaget modelled this movement (1945/61, obs. 5). However, I felt that the poor head control typical of infants up to three months of age might militate against a positive result if the infants were seated in a chair or on someone's knee. Lying down the infants' heads were supported, and could be moved up and down. Piaget does not tell us how close he was to his subject, but if that subject had to move her head up and down to follow his movement, he must have been very close indeed, as none of the infants in this study showed any such following movements with the head.

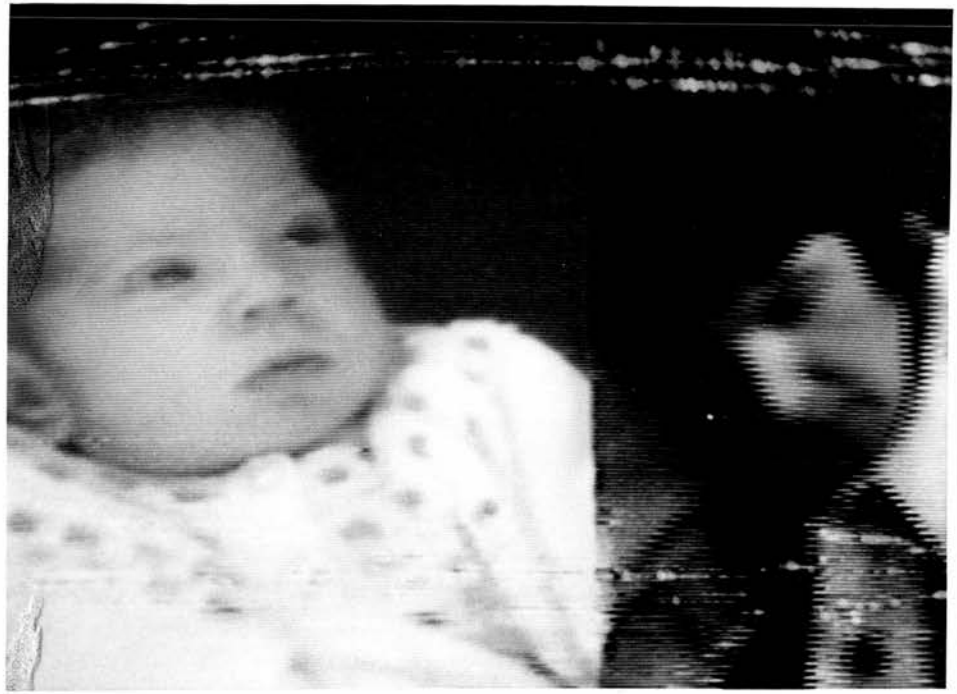


FIGURE 4: IMITATION OF TONGUE PROTRUSION
IN AN INFANT AGED 23 DAYS

The tongue protrusion model was imitated and all five of the infants whose behaviour showed this clearly on the first trial imitated again on the second trial, ruling out the possibility of "pseudo-imitation" (unless the mothers had ignored my request not to practise the child - rather an unlikely possibility given the fact that most of them showed obvious surprise when later told the true purpose of the study). An example of tongue protrusion is shown in Figure 4. The results of the statistical analysis clearly demonstrate that imitation of this movement is possible. Actually watching the videotape conveyed a strong feeling to an observer that the infants were imitating; particularly on those occasions when an infant seemed to be trying to protrude his tongue, watching his mother intently all the time, and only succeeding in pushing out his lower lip with the tongue (which of course could not be counted) before actually managing to do so.

CHAPTER 6EXPERIMENT IIIOpening and closing the mouth and moving the fingers

The purpose of this experiment was to attempt to replicate Gardner and Gardner's (1970) observation of opening the mouth in imitation a six week old infant, and Moore's finding of finger movement imitation in neonates (Bower, 1971, pers. comm.). Piaget (1945/62) did not find such movements were imitated until 10 and 6 months of age respectively.

METHODSubjects

Eight infants, four boys and four girls, served as subjects. Their ages ranged from 3 - 13 weeks (mean age 56.63 days, s.d. 24.51 days). All were full-term, normal, healthy infants.

Modelled behaviours

The model of opening and closing the mouth consisted in the model opening wide and then closing her mouth, and then after an interval repeating the movement if the infant were still watching her. This movement took about 3 seconds. The hand movement consisted in moving the fingers slowly, as if playing a scale, with the right hand. The movement was repeated after a pause if the infant was watching. The hand was lifted to approximately shoulder level in order to be clearly visible to the infant.

Procedure

The procedure adopted in Experiments I and II was altered for this study. A split-screen two camera image would not give a sufficiently large view of the infant for accurate analysis of hand and face movements. Therefore, the infants in this and the subsequent experiments on imitation sat in a standard baby seat angled slightly backwards, well propped with

pillows to prevent them from falling to one side. The mother with their faces about 40 cm. apart sat directly in front of the infant. Behind the infant to his right was a large 3" by 2" mirror, so that a single HVL53 Video camera could record the infant's whole body and a smaller mirror image of the mother. The mother's head was higher than the infant's, but all mothers inclined their faces to the infant so that they were in the en face position. Apart from this Procedure, Instructions to mother and Observation period were as in the previous experiments. Length of time of any condition was however shortened from 5 minutes to 4 minutes, as in Experiment II it had seemed that some of the infants were becoming bored by the end of experiment.

RESULTS

Scoring of data

As before, an observer scored the tapes blind, the portion of the monitor screen with the mother's image being covered over. The hand movement was scored by measuring all the time periods in seconds in which the infant's fingers of either or both hands were seen to move. Finger movements when the infants were touching their clothes (and it is very common for infants of this age range to finger their clothes) or were touching the other hand were not counted. Each tape was scored twice, once for movement of one hand and then for movement of the other.

Mouth opening was scored when the infant obviously opened its mouth. The mouth must close again before another mouth opening movement could be scored. Only mouth opening movements from a position where the mouth was shut or only just open could be scored, i.e. if the infant's mouth was already open a further movement was not scored. Mouth opening to insert the fingers and yawning were not counted.

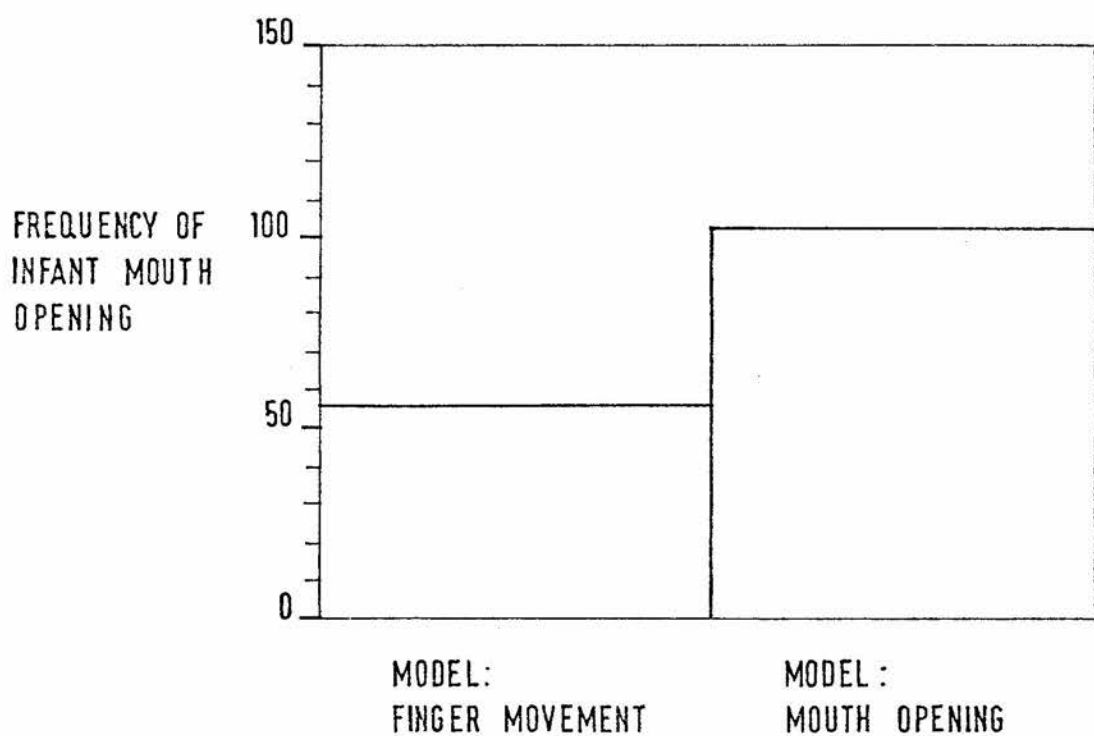
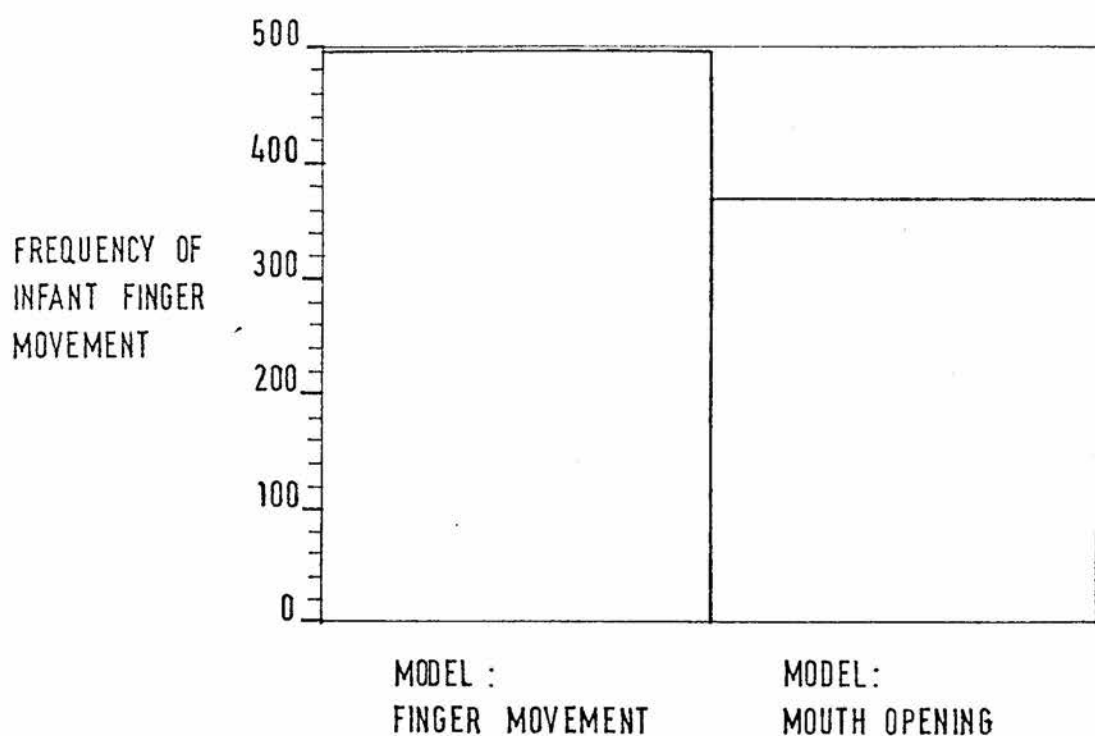


FIGURE 5 : RESULTS OF EXPERIMENT III

Tongue protrusions were also not counted as mouth opening.

Results of data analysis

Analysis of a random sample of tapes of eight trials showed that in these the mean number of times the mouth model was presented was 44.5 (s.d. 17.68); the finger movement model was almost continuous through the trials. The results of this experiment are shown graphically in Figure 5.

The amount of time infants moved their fingers in both conditions is shown in Table 4. Two infants cried continuously throughout the second trial and their movements could not be scored.

TABLE 4

Time spent (in seconds) by infants moving their fingers in the two conditions

<u>Subjects by age in weeks and days</u>	<u>1st trial</u>		<u>2nd trial</u>	
	<u>Model</u>		<u>Model</u>	
	Finger moving	Mouth opening	Finger moving	Mouth opening
1. 3.1	128	142	61	8
2. 4.1	5	8	86	37
3. 6.0	60	10	-	-
4. 7.0	0	3	-	-
5. 8.1	33	23	3	7
6. 10	26	6	26	96
7. 11.4	12	0	30	14
8. 13.5	23	10	6	6
Total	287	202	212	168
Mean	35.87	25.25	35.33	28
s.d.	41.66	47.66	32.4	35.28

Results of both trials summed.

	<u>Model</u>	
	Finger Moving Mouth opening	
Total	499	370
Mean	35.64	26.42
s.d.	36.58	41.28

t-tests for correlated pairs of means were carried out. There was no significant difference between the amount of time the infants moved their fingers when the model was doing so and when she was opening her mouth ($df = 7$, $t = 1.44$, n.s.). The null hypothesis was therefore retained.

The results of the mouth opening movement analysis are shown in Table 5.

TABLE 5

Number of mouth opening movements made by the infants in the two conditions.

<u>Subjects by age in weeks and days</u>		<u>1st trial Model</u>		<u>2nd trial Model</u>	
		<u>Finger moving</u>	<u>Mouth opening</u>	<u>Finger moving</u>	<u>Mouth opening</u>
1.	3.1	9	11	5	5
2.	4.1	3	8	6	3
3.	6.0	7	17	0	-
4.	7.0	5	12	-	-
5.	8.1	8	12	2	4
6.	10.1	0	0	1	8
7.	11.4	0	4	4	6
8.	13.5	2	5	4	7
Total		34	69	22	33
Mean		4.25	8.63	3.66	5.5
s.d.		3.54	5.45	1.86	1.87

Results of both trials summed.

Model

	<u>Finger moving</u>	<u>Mouth opening</u>
Total	56	102
Mean	4	7.29
s.d.	2.86	4.46

t-tests for correlated pairs of means were carried out. Infants did over the results of both trials open their mouths significantly more often when the same movement was being modelled than when the finger moving model was presented ($df = 7, t = 6.12, p < .01$). However, this significance derived from the results of the first trial, since the difference in that trial was significant ($df = 7, t = 4.05, p < 0.01$) while in the second trial there was no significant difference between the frequency of mouth movements in the two conditions ($df = 5, t = 1.63, n.s.$).

Order of presentation of the mouth opening model seemed ineffective; 60.7% of all imitative responses occurred during presentations where it was the first model shown. Age was not correlated with imitative performance, ($r = -0.24$).

Apart from the obvious exceptions (Infants 3 and 4) the infants seemed relatively happy during the experiment. However, many of them protruded their tongues frequently, making analysis difficult. The mean frequency of tongue protrusion in the finger moving condition was 11.5 (s.d. 12.4) and in the mouth opening condition was 11 (s.d. 12.77). Most of these tongue protrusions were observed in the two youngest and in the oldest subjects.

DISCUSSION

Because it was the subjective impression that at least one infant (infant no. 3) was imitating the hand movement, the lack of statistical significance in the results was disappointing. Infants were not observed to look at their own hands, although they did watch the model's hand. The four oldest infants in trial 2 of this experiment spent most of their time either chewing their hands or fingering one hand with the other. This precluded the inclusion in the analysis of many of the finger movements they made. None of the infants were seen to raise



FIGURE 6: IMITATION OF MOUTH OPENING
IN AN INFANT AGED 22 DAYS

their hands to the same position as the model; the hands were kept close to the body.

That the infants did imitate mouth opening movements in Trial 1 is clear. An example is shown in Figure 6. Why infants did not imitate in Trial 2 may be explicable in view of the observation above that 66.6% of the infants who completed this part of the study had their hands in their mouths much of the time. It may have been the case that these infants were showing subtle signs of distress or these may have been attempts at imitation that failed comparable to the confusions between bodily parts Piaget noted (1945/62 obs. 25, 28, 29, 30 and 31). The confusions of movement Piaget described did, however, retain some general connection with the model's movements (i.e. opening or shutting the wrong part of the body) except for Obs. 28, where an infant raised a finger when tongue protrusion was modelled. Because neither the frequency of tongue protrusion nor the amount of hand chewing seemed to vary with the model the former hypothesis may be more likely to be true; but there is no means of ascertaining this. The mean frequency of tongue protrusion during both models was nearly as high as that obtained when a tongue protrusion model was presented in Experiment III. It is not obvious in any case why mouth opening and finger moving models should have had any distressing effect. Imitation does, then, occur; but it is not lasting and so may be "pseudo-imitation".

CHAPTER 7EXPERIMENT IVOpening and shutting the eyes and putting the hand to the mouth

The purpose of this experiment was to attempt to replicate Piaget's findings on imitation of these movements with younger infants (1945/62). Both these movements he found were imitated at about the same age as was tongue protrusion; since I have shown some evidence that this may be able to be imitated at ages younger than those of his subjects, it might be the case that this is also true for opening and shutting the eyes and for arm gestures. The arm gesture Piaget used was to put the finger in the mouth; but in case this lead to chewing the hands as described in Experiment III, I decided to use a different gesture, one which was not so exact and therefore perhaps more likely to be imitated.

MethodSubjects

Six infants, three boys and three girls, served as subjects; their ages ranged from 3 - 15 weeks on the date of the first trial (mean age 60.83 days, s.d. 27.5 days). All were full-term, normal, healthy infants. Two infants required two visits before the first trial could be carried out. Two other infants cried so much during the second modelling condition on the second trial that movement data was unobtainable.

Modelled behaviours

Opening and shutting the eyes was modelled by the mothers. Mothers varied in how long they kept their eyes shut; but this normally

took about two seconds, and mothers were asked to repeat the movement when the infant was attending.

The arm gesture used was to move the arm until the palm of the hand covered the mouth. This took about three seconds, and was repeated as above.

Procedure

The infants sat in an infant chair as in Experiment III, and the instructions to the mother were as in Experiments I and II. Infants were exposed to the different conditions in a counterbalanced order which was reversed on the second trial approximately one week later. The observation period was however altered. The infant was observed for one minute before testing began and note taken of the times of any hand to mouth gestures or blinking. It would obviously have been impossible to wait until the infants had not shut their eyes for a minute before beginning the trials.

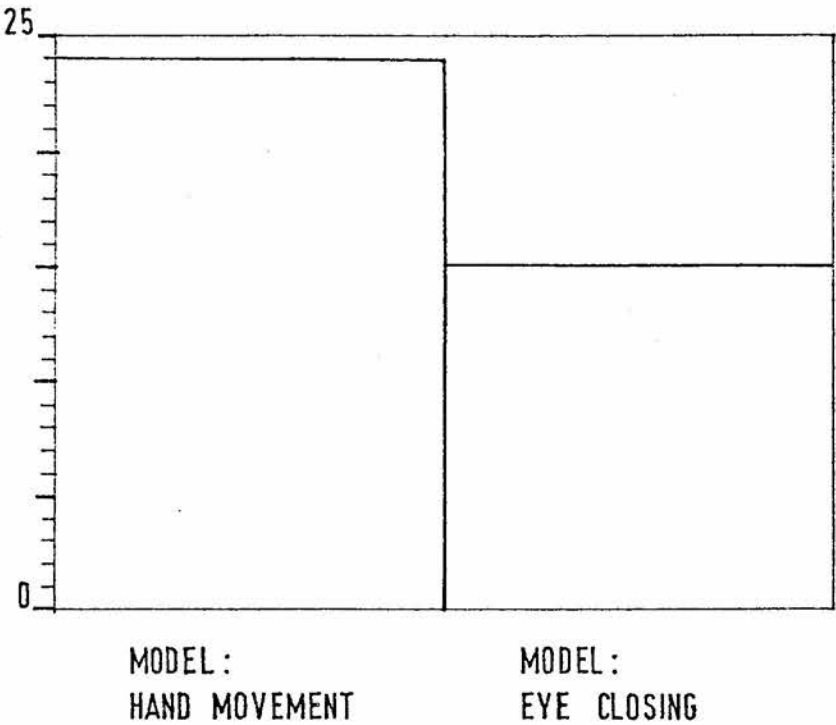
RESULTS

Scoring of data

As before, an observer scored the tapes unaware of the action the mother was making. The criterion for opening and shutting the eyes was simple; the infant had merely to blink.

For the arm gesture, it was decided that only a movement of the hand from a distance of at least one hand's breadth from the face to touch the lower portion of the face would be acceptable as imitation, and only then if the other hand were not already touching the face (in case the intention was only to touch the other hand). For this experiment electronic timing was possible in analysis by means of a VTG 33 For-A-Co Video timer.

FREQUENCY OF
INFANT HAND
MOVEMENT



FREQUENCY OF
INFANT EYE
CLOSING

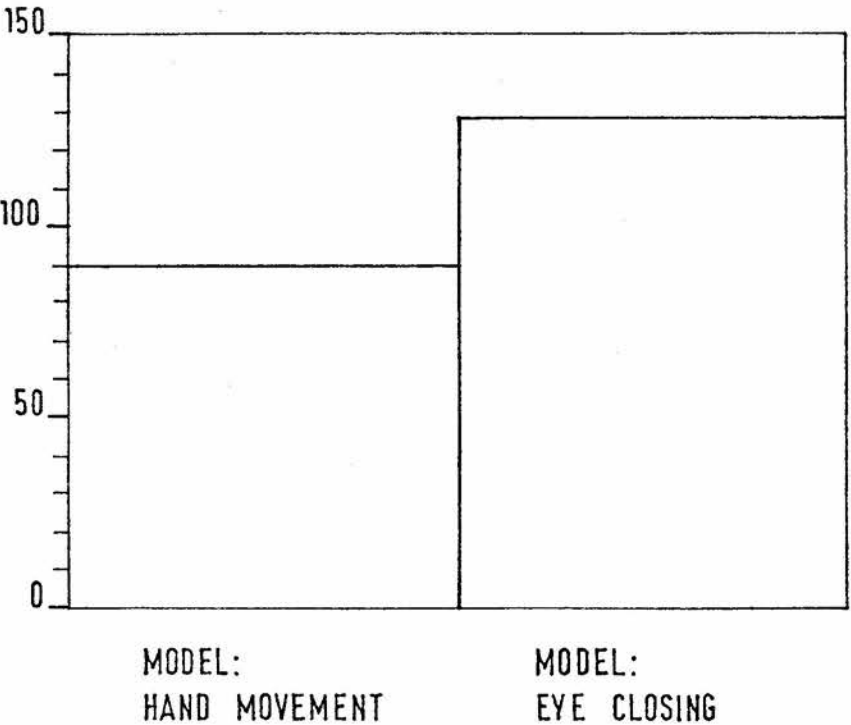


FIGURE 7 : RESULTS OF EXPERIMENT IV

Results of data collection

Data was collected on all instances of the mother producing both models; the mean number of times the hand model was presented on a trial was 17.2 (s.d. 6.1) and the mean number of times the eye model was presented was 21.2 (s.d. 9.7). The mean length of time the infants watched the mother during a four minute trial with the hand model was 3 minutes 2 seconds; they watched the eye model for a mean length of time of 2 minutes 40 seconds.

The mean time before the experiment began in which blinking was seen was 19.33 seconds (s.d. 20.64) and in which a hand gesture was seen was 55.83 seconds (s.d. 14.43). These times seem sufficiently long to rule out the possibility of imitation by the mother beginning a sequence of seeming imitation in the child (mutual imitation). In only one case did an infant make a movement simultaneous with the beginning of the modelling behaviour and since the movement concerned was eye closing this was irrelevant.

Figure 7 shows the results of the experiment graphically.

Table 6 shows the number of hand movements the infants made in the two modelling conditions.

TABLE 6Number of infant hand movements in the two conditions

<u>Subjects by age in</u> <u>weeks and days</u>		<u>1st trial</u> <u>Model</u>		<u>2nd trial</u> <u>Model</u>	
		Hand movement	Eye closing	Hand movement	Eye closing
1.	3.4	2	3	-	0
2.	7.4	0	0	0	0
3.	7.5	2	-	2	2
4.	8.1	5	2	8	4
5.	8.5	0	0	1	1
6.	15.5	1	3	3	-
Total		10	8	14	7
Mean		1.66	1.33	2.8	1.4
s.d.		1.86	1.51	3.11	1.67

Results of both trials summed.

Model

	<u>Hand movement</u>	<u>Eye closing</u>
Total	24	15
Mean	2.18	1.36
s.d.	2.44	1.50

A t -test for correlated pairs of means was carried out on the total sum of hand movements in the two conditions. This showed that there was no significant difference in amount of arm movement between the two conditions ($df = 5$, $t = 1.28$, n.s.).

Table 7 shows the number of times the infants closed their eyes in the two conditions.

TABLE 7

Number of times infants closed their eyes during the two conditions

<u>Subjects by age in weeks and days</u>		<u>1st trial Model</u>		<u>2nd trial Model</u>	
		Hand movement	Eye closing	Hand movement	Eye closing
1.	3.4	6	17	-	5
2.	7.4	19	24	3	4
3.	7.5	8	6	11	7
4.	8.1	12	15	8	14
5.	8.5	3	11	4	12
6.	15.5	9	14	7	-
Total		57	87	33	42
Mean		9.5	14.5	6.6	8.4
s.d.		5.54	6.02	3.21	4.39

Results of both trials summed.

Model

	<u>Hand movement</u>	<u>Eye closing</u>
Total	90	129
Mean	8.18	11.72
s.d.	4.67	6.00

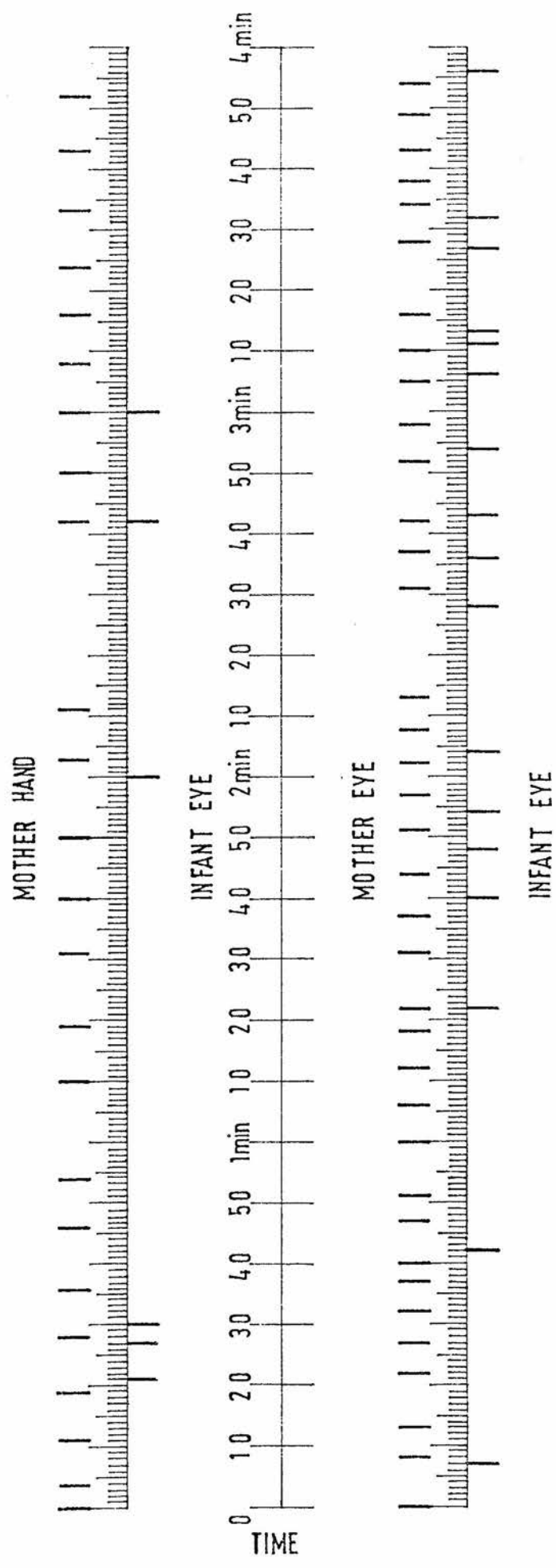


FIGURE 8.

A t-test for correlated means revealed that there was no significant difference between the number of times the infants closed their eyes during the two conditions ($df = 5$, $t = 1.75$, n.s.). However, inspection of the table suggested that in the first trial this comparison might be significantly different, and a further t-test showed that this was the case ($df = 5$, $t = 2.77$, $p < .05$). There was no significant difference in amount of eye closing in the second trial between the two conditions ($df = 4$, $t = 0.9$, n.s.).

There seemed to be no function of order when imitative eye movements by the infant were compared. When eye closing was the first model, 41.7% of all such eye movements occurred. Age was not correlated with imitative performance ($r = 0.39$).

The electronic timing device made possible accurate measure of the times of all infants' and mothers' behaviours. It might be possible to detect patterns of imitation if mother's and infant's behaviour were plotted over time. Accordingly for the youngest infant's first trial (where the greatest difference in frequency of eye closing occurred) mother's and infant's behaviours were compared as shown in Figure 8. From this figure, it is clear that (on three of the five occasions when she did so), the infant was shutting her eyes shortly after the model had made the arm movement. The times in the condition where the model was closing her eyes would also seem to indicate that the infant was synchronising her behaviour with that of the mother. Whereas the sequence beginning at 1 minute 57 seconds might be considered true imitation, that beginning at 2 minutes 28 seconds could be mutual imitation, since 15 seconds had elapsed since the infant last saw the mother's eyes close. Since this infant's pattern of behaviour was so difficult to interpret another time measure was taken. If infants are imitating eye closing then it might reasonably be expected that their

first closure of the eyes would occur sooner when the mother was making that same movement than when she was making another movement. Table 8 shows the latency of the infant's first eye closure from the time the model first made a movement.

TABLE 8

Latency (in seconds) of the first eye closure in the two conditions

<u>Infants by age in weeks and days</u>		<u>Trial 1</u>		<u>Trial 2</u>	
		<u>Model</u>		<u>Model</u>	
		<u>Hand movement</u>	<u>Eye closing</u>	<u>Hand movement</u>	<u>Eye closing</u>
1.	3.4	21	7	-	25
2.	7.4	32	1	2	23
3.	7.5	35	2	9	69
4.	8.1	4	2	50	47
5.	8.5	13	0	45	4
6.	15.5	35	7	11	-
Total		150	19	117	168
Mean		23.33	3.17	23.4	33.6
s.d.		12.9	3.06	22.32	24.98

Total summed over trials.

	<u>Hand movement</u>	<u>Eye closing</u>
Total	257	187
Mean	23.36	17
s.d.	16.81	22.51

A t -test for correlated pairs of means revealed that there was no significant difference overall between the times of first eye closure in the two conditions ($df = 5$, $t = 0.89$, n.s.). However, in view of the evidence above that infants might have been imitating in the first trial a t -test was carried out with the data on times from that trial, and the difference between time of first eye closure in the two conditions was significantly different ($df = 5$, $t = 4.02$ $p < .05$). A t -test between the times of first eye closure in the two conditions on the second trial was not significant ($df = 3$ $t = 0.44$, n.s.).

DISCUSSION

While there is no statistical evidence for imitation of hand movement in this study the impression nonetheless remained after inspection of the videotapes that infant 4 was imitating hand movement on the second trial. Infant 8 repeatedly brought both hands clasped together to the mouth in trial 1, which of course could not be counted. Infant 2 looked extremely puzzled throughout the first trial of this model and waved her arms around.

There is evidence from the first trial of the eye closure model that infants were imitating this movement, but the second trial results were not significant, not unsurprisingly given the high level of distress found in that part of the experiment. The results of the latency analysis are interesting, lending support to the significance of the finding of imitation in trial 1; but may be merely a consequence of the lower frequency of eye closure in the hand movement condition than in the eye closure conditions. It is, of course, always possible that the infants closed their eyes more often when the mother was performing this gesture than when she was moving her hand because the sight of the mother closing her eyes was aversive.

There seems to be some evidence, then, of eye closure imitation; but it is not lasting and may therefore be "pseudo-imitation".

CHAPTER 8EXPERIMENT V

This experiment was designed to replicate Piaget's (1945/62) observations that older infants (6 - 10 months) are incapable of systematic imitation of novel movements, even when these movements occur as part of other schemas and so are familiar, or are visible to the child. Thus, not until the age of $11\frac{1}{2}$ months was J. able to immediately reproduce her mother's action of striking a duck with a comb, and Piaget's action of striking a xylophone with a hammer.

In this experiment I examined infants' ability to repeat the action of touching two objects in a particular order, after having had that action modelled for them. If they were successful, then a light would be turned on and a buzzer sounded, as had happened when the model performed the action. Infant motivation should be very high in this experiment; by touching the objects in the correct order the infants would not only succeed in imitating the mother precisely but they would also receive the same reinforcement for that act as the model had done.

It would not be sufficient, I considered, for the infant to touch only one object in imitation. Merely having had their attention drawn to an object might well predispose infants of this age to touch or strike it. If two objects must be touched in a particular order then since attention must be shifted from the last button the model touched to the first one she touched for successful imitation to take place then any reproduction which does take place cannot be ascribed to attentional factors.

If having been exposed to one model and succeeded in repeating it the infant is exposed to a different model and soon repeats that also then the likelihood of this result having occurred, by chance or through

processes of operant conditioning must be low.

METHOD

Subjects

Four female and four male infants, aged 23 - 39 weeks of age (mean age 209 days s.d. 35.8 days) served as subjects.

Apparatus

A table with a blockboard top, 127 x 59 cm. with a semicircle of radius 18 cm. cut out at the front was used. The cut-out allowed the infant freedom of action on the table. Three round coloured buttons (red, yellow and blue) of diameter 3 cm, and thickness 0.5 cm. were situated in a semicircle 12 cm. apart from each other on the table top, with one in the midline and the others to right and left, all within easy reach of the infant. Connected to these buttons from underneath the table was a 20 x 15 x 8 cm. grey box containing a buzzer; on its top was a 5 watt light bulb 2 cm. in diameter and a peg-box grid. This box was in full view of the infant directly in front of him but out of reach. This was powered by a 12 volt battery out of sight under the table. By altering the pattern of pegs in the grid the experimenter changed the sequence of actions needed to activate the buzzer and light. A Sony CV2100 ACE VTR recorded the infant's behaviour through a Shibaden HV15S video camera and on AKG microphone, providing a clear record of the infant's facial and manual behaviour.

Procedure

The infant was seated on the mother's knee in front of the table. The mother, with her right hand, modelled one of four actions, encouraged the infant to imitate her (verbally) and then repeated that action until mother and experimenter thought the infant had learned

the task or was losing interest. Then one of the other actions was demonstrated. After a period of time with this model, if the infant were still interested, a third action was modelled. The mother's action took 2 - 3 seconds to complete. On each occasion the mother demonstrated an action the light went on and the buzzer sounded. The experiment took place over approximately one week, with each infant being tested twice in that time.

The four actions were -

- I Touch button 1 then button 2
- II Touch button 2 then button 1
- III Touch button 2 then button 3
- IV Touch button 3 then button 2

(Button 1 was to the infant's left, 3 his right, and 2 was in the midline).

The models of touching the buttons in the sequences 1, 3 and 3, 1 or any involving three buttons were considered too complex for infants of this age range.

All the infants began with either Model I or Model III, which were thought to be the easiest movements. The other models were then presented in a counterbalanced order as far as this was possible. Infants were exposed to a mean of 2.11 models; all infants saw more than 1.

RESULTS

Scoring the videotapes

The experimenter noted from the videotape record the number of demonstrations of each model by the mother and all the instances where the infant had touched a button. Because of the difficulty of assessing a truly accidental response, and the bias such an analysis might lead

to, even those responses which were undoubtedly accidental were counted e.g. where an infant touched a button with his elbow. Such responses were comparatively rare. Where an infant touched two different buttons one after the other in the period following demonstration by the model this was counted as a sequence, unless this action was immediately followed by touching the third button and activating the reinforcement, when the first touch was considered a single touch and the latter two a sequence. The audio track allowed clear confirmation of success, i.e. of the infant triggering the buzzer.

Results of data analysis

All the infants used the right hand most of the time; occasionally they would touch one button with each hand.

Infants touched a button during their first condition a mean of 9 times (s.d. 7.97), their second 7.5 times (s.d. 5.48) and their third 8.67 times (s.d. 0.58).

The total number of times the infants in this study touched the buttons singly or in particular sequences is shown in Table 9, with the mean number of times the mothers modelled each action shown in parentheses.

TABLE 9

Total number of infant responses in the four conditions.

<u>Model</u>	<u>Infant response</u>								
	1,2	2,1	2,3	3,2	1,3	3,1	1	2	3
I 1,2 (8.43)	7	0	5	0	2	0	5	3	5
II 2,1 (6.5)	1	1	2	0	0	1	3	5	4
III 2,3 (4.67)	1	2	6	0	0	0	3	13	20
IV 3,2 (7.25)	3	0	3	5	1	0	2	2	14
Total	12	3	16	5	3	1	13	23	43

A χ^2 test was carried out on the data for instances of touching 2 buttons, and this gave a significant result ($df = 15$, $\chi^2 = 46.8$ $p < .001$) indicating that the distribution of response was not random, i.e. that infants did tend to perform the same action as the model.

In considering the models separately, however, it was evident that only models I and III were imitated ($df = 5$, $\chi^2 = 17.08$ $p < .01$ and $df = 5$, $\chi^2 = 18.34$ $p < .01$ respectively) while Models II and IV were not ($df = 5$ $\chi^2 = 3.38$, n.s. and $df = 5$, $\chi^2 = 8$, n.s., respectively).

The results shown in Table 11 seemed to indicate that the infants' errors when they touched two buttons were not randomly distributed, and that they were more likely to touch the buttons in the correct spatial order, i.e. right to left or left to right, than in the wrong spatial order. Accordingly I calculated the percentage of correct to incorrect spatial orders of touching the wrong two buttons. However, the direction of movement of the model produced no difference in the

order of the infants' response; infants touched the buttons in the direction left-right 75% of the time and right-left 25% of the time, irrespective of whether the model was right-left or left-right.

Models I and III were perhaps more likely to be imitated then because they involved movement in the direction in which the infants were most likely to move their hands in any case, or infants may have conserved the direction of the movement of the first model (which was always left-right) throughout the experiment, i.e. imitated the direction of the movement. That the latter hypothesis may in fact be correct is suggested by comparison of the direction of errors in the trial with the first model compared with the direction of the errors in the second and third model periods. Whereas 57.1 of the incorrect responses of touching two buttons were in the direction left-right during the first model, 91.8 of the incorrect responses in the second and third modelling periods were in this direction. This result must be regarded with caution, when the frequency of touching only a single button is considered.

A χ^2 test on frequency of touching single buttons was also significant, where the frequency of touching the same buttons as the model was compared with the frequency of touching the other ($df = 3$, $\chi^2 = 9.56$ $p < .02$). However, frequency of touching the same buttons as Models I and II was not significantly different from that which would be expected by chance ($df = 1$, $\chi^2 = 0$ n.s. and $df = 1$, $\chi^2 = 0$, n.s.) while the frequency of touching the same buttons as the Model in III and IV was significantly different from that which would be expected by chance ($df = 1$, $\chi^2 = 5.56$ $p < .02$ and $df = 1$, $\chi^2 = 4$ $p < .01$ respectively). The parsimonious and most likely explanation of these

findings is that infants tended to touch the buttons nearest the right hand, whatever the model, when they touched only a single one.

Another way of analysing these results is to compare accuracy of the response of touching two buttons over time. If infants were able to learn to imitate a model on the first presentation, were they able to transfer this learning to a second model. It is this question which is most important for this study. Table 12 shows the proportion of times that infants touched two buttons in the correct to any incorrect orders, during their first, second and third models.

TABLE 12

Proportion of correct to incorrect sequences over three models.

Model	Correct	Incorrect
1	0.65	0.35
2	0.375	0.625
3	0.28	0.72

It is clear then that the infants' performance did not improve over time, i.e. any imitation shown in response to the first model did not transfer to the second or third. It was not the case that the reduction in accuracy between the first and second and between the second and third models was a function of infants persisting with the first or second model when the second or third was presented. Of the incorrect responses of touching two buttons during the second model only 20% were instances of touching the buttons in the order of the first model, and of the incorrect responses in the third model none were of the second.

In general, infants were happy and interested in the test, although frustration and annoyance tended to increase during the trials, as infants patently failed to achieve their goal, triggering the light and buzzer. One infant, aged 29 weeks, impressed both his mother and myself by the ease with which he imitated the model. Model I was presented ten times, and the infant reproduced this five times, with one error - touching only the first button in the sequence. Model II was presented twice, and the infant reproduced this perfectly once, again making one error - touching only the first button in the sequence after which he refused to co-operate any further.*

DISCUSSION

Although the infants seemed to be interested in the task in this experiment and their motivation seemed high, all but one failed to demonstrate any capacity to transfer any learning of imitation from one model to another model.

It is of interest that Abravanel et al. (1976) found more imitation of action with objects than action without objects, in a study in which they presented 44 infants aged 6, 9, 12 and 15 months with models of 22 actions, e.g. patting an object, scribbling (actions with objects)

* After analysing the results of the experiment I contacted the infant's mother and asked if she could think of any reason why her infant should have been able to imitate these actions so much more easily than the other infants seemed to have been able to do. She told me that she loved to play the piano, and that the infant had been used from an early age to accompanying her- a clear example, I assume, of "pedagogic mania".

mouth opening, tongue protrusion (actions without objects).

With infants of a comparable age to those in this study they found more evidence of imitation of patting an object than of tongue protrusion or mouth opening. However Abravanel et al. do not give precise details of the procedure employed in the control experiment, where spontaneous behaviour of the modelled actions was noted, with which behaviour in the treatment groups (those exposed to models) was compared. I have argued above that any infant of this age is more likely to touch an object if his attention had been drawn to it than if it has not; and from the description of the procedure Abravanel et al. furnish it is not clear whether or not someone drew the infant's attention to the object in their control experiment.

Piaget's observation that infants of this age are unable to imitate novel movements systematically even when these involve parts of the body which are visible, is thus substantiated by this study.

CHAPTER 9

EXPERIMENT VI

This experiment was designed to replicate Piaget's finding that by the age of 18 - 24 months children could act on the basis of literal or pictorial representations. Thus at 15 months J. lay down and pretended to sleep on a "pillow" which was in fact a rubber donkey's tail (Piaget 1945/62 obs. 64). At 18 months of age J. noticed a photograph in a newspaper of a boy with his mouth open, whereupon she opened her own mouth. The ability to recognise pictorial representations of objects is unlearned, according to Hochberg and Brooks (1962). They report that an infant brought up with hardly any experience of pictorial representation and no training in pictorial meaning could at 19 months of age correctly name line drawings and photographs of familiar objects on their first presentation. That the infant recognised both types of representation implies that the fidelity of the representation is not crucial, as he was shown the line drawings first. Other investigators have however found that photographs are recognised faster, by older subjects, when presented tachistoscopically than are line drawings (Ryan and Schwartz, 1956; Fraisse and Elkin, 1963).

The design of an experiment to study the phenomenon of ability to act on the basis of a representation posed some problems, not least of which was that an action is difficult to represent in a static form. To present representations of facial or bodily movement to infants at this stage of development did not seem worthwhile. The infants would either imitate or not imitate. If they did not, it would be impossible to conclude this was a result of inability to recognise the picture, of reluctance to perform the task, or of

unfamiliarity with the gesture, or for some other reason.

I therefore decided to present representations of different fidelity of an object permanence task. By the age of 18 months or so (Piaget 1937/55) infants are able to discover a hidden object even though its displacements are invisible and must be inferred. If infants could find a hidden object when its displacement was completely invisible and must be inferred from a representation of its eventual location then it would be clear that they not only recognised the representation but could act on it. They would understand that the representation actually stood for the object-permanence task, using representation in its second sense.

METHOD

Subjects

4 girls and 4 boys of age ranging from 19 - 33 months (mean age 25.56 months, s.d. 5.63 months) served as subjects. All had been exposed to picture books, television etc., and all had been tested with a version of Stage V of Piaget's object permanence task, and been successful.

Apparatus and stimuli

The infant was seated on the mother's knee in front of a table with a blockboard top measuring 127 by 59 cm. on which were 2 cups of base diameter 7 cm. and height 9 cm. which were about 12 cm. apart. One of these was yellow and the other multicoloured. The cups were placed horizontally with respect to the infant and on each side of the midline. The stimuli used by the experimenter fell into four Categories, the first three of which were pictorial and the fourth literal.

1. Glossy full colour Polaroid photographs measuring 11.5 x 9 cm. showing the two cups on the table, with one tipped slightly back to show a raisin underneath it. The cups were approximately half real size. There were four of these photographs; every combination of position of cups and raisin could be presented.
2. Glossy black and white Polaroid photographs identical in size and content to those in Category 1.
3. Line drawings on a piece of white paper (25 x 20 cm) showing two cups with one tipped back to expose a raisin. The cups were full size. There were two of these drawings; in one the raisin was under the cup on the left, in the other under the cup on the right.
4. Two more cups identical to those in front of the infant.

Procedure

The infant sat on the mother's knee in front of the table, and was presented with twelve trials of each of the tasks in the four categories, in a counterbalanced order of categories and a random order of position of cups within categories. The procedure in Categories 1 - 3 was for the experimenter to place in front of the child the two test cups, under one of which a raisin had been hidden. Then I gave the infant the photograph or line drawing to look at saying "look at the picture". After twenty seconds or so I retrieved the picture and held it directly above the cups but slightly behind them and said "now you find a raisin". If the child did find the raisin at the first attempt, he was allowed to eat it. If he made no move or pointed to the raisin in the picture, I said "now you pick up a cup and find a raisin" and if he chose the wrong cup, I

removed the cups and went on to the next trial. For the tests in the fourth Category I hid a raisin under the other set of cups, to the right of the test set and slightly behind, so as to be out of reach. Then I lifted the correct cup several times, pointing out the raisin and saying "look, there's a raisin" and then "now you find a raisin." If the child made a move towards the other set I said "no, not those cups". Mothers had been asked beforehand not to say anything to help the children, and the relation between the photographs, drawings and real cups was never explained.

RESULTS

I marked on a scoresheet whether or not the infant had succeeded in obtaining the raisin on the first attempt, and if he did so this was counted as a pass. Efforts to lift both cups (which were frequent) were counted as failures. In Categories where the infant had refused to continue a failure was scored. A complete pass for any Category was allowed if the infant succeeded on 75% of trials, which result has a probability of $p < .07$ of arising by chance (Binomial Test). Table 10 shows the results of the experiment.

TABLE 10

Success rates as a percentage of total number of trials with the
four categories of stimuli

Infants by age				
	<u>CATEGORY</u>			
	1. (Coloured)	2. (black & white)	3. (line)	e. (real)
1.	66.67	-	-	66.67
2.	58.33	-	-	50.00
3.	50.00	-	-	50.00
4.	41.67	41.67	33.33	41.67
5.	83.33	58.33	-	66.67
6.	50.00	-	75.00	58.33
7.	100.00	100.00	75.00	58.33
8.	100.00	83.33	33.33	75.00
Mean	68.57	70.83	54.15	58.33
s.d.	23.04	25.91	24.08	10.91
- not completed.				

It is clear that only the two oldest infants passed on more than two Categories, and that Categories 3 and 4 were particularly difficult for all the children. Younger infants typically cried and refused to continue, threw the cups on the floor, kicked the table, etc., particularly with tasks in Categories 2 and 3. Frustration was

very evident from their behaviour. Three resorted to always picking up the cup on one particular side, but even this partial success (as far as eating raisins was concerned) was not sufficient to sustain their interest.

To test the effects of practice the two youngest infants repeated the experiment at weekly intervals until they refused to continue. Because the procedure might have been too long on their first experimental session they were tested only on 12 trials of Category 1 and 12 of Category 4. The procedure was modified in Category 4. The raisin was left visible, just under the lip of the cup. The results of this second part of the experiment are shown in Table 11.

TABLE 11

Two infants' success rates on further trials with Categories 1 and 4.

Infant	Category	Experimental trials			
		2	3	4	5
1	1	50.0	66.67	50.00	50.00
1	4	50.0	58.33	50.0	66.67
2	1	6.67	50.00		
2	4	50.00	50.00		

Both infants were completely unsuccessful even with this practice, and by the end of the experimental trials were absolutely fed up with the whole situation. Infant 1 resorted to picking up both cups every time, and Infant 2 to picking up the left cup every time. Even the fact that the raisin was perfectly visible underneath the cup in Category 4 trials did not improve the performance.

DISCUSSION

That the infants' inability to succeed in these experiments was not due to a failure to recognise the stimuli was quite apparent from their reaction when asked to find a raisin, since they all at some time pointed to the raisin in a picture or tried to reach the other set of cups in Category 4. The difference in behaviour between younger and older infants with the stimuli in Categories 1 - 3 was striking; younger infants often threw them on the floor, tried to turn them upside down, laid them face down on the table, and so on, while older infants did seem to attend to them carefully before making a choice. It was quite clear the younger infants saw absolutely no connection between the most veridical of pictorial representations of the cups and the real cups just below those representations. More surprising still was the failure of all but one of the infants to comprehend the relation between the literal representations in Category 4 and the test cups. Their attention had been drawn to only one of the cups; I had modelled lifting that cup and finding a raisin; lifting cups could hardly be likely to be novel experience, and yet the infants could not choose the correct test cup more frequently than would be expected by chance. That the infants forgot which cup the raisin was under was hardly a likely explanation. The time elapsing between the conclusion of the demonstration and the infant's being allowed to choose a cup could have been at the most two or three seconds. In any case, even when the raisin was left completely visible under the stimulus cup in tests of Category 4 with the youngest infants, they could not use this information to help them in choosing the correct test cup. I therefore decided that longitudinal testing of older infants might elucidate the nature of the phenomenon under study.

CHAPTER 10EXPERIMENT VII

This experiment was basically the same as Experiment 6, except that the stimuli in Categories 1 and 2 were 24 x 16.5 cm. photographs of the cups, showing them exactly full size, which I thought might make the task easier. In addition, all vocalisations made by the children which pertained to the experiment were noted. I had observed that the only child who had passed in three categories in Experiment VI had commented on the photographs before choosing a cup, and thought this might be relevant.

Subjects

Three boys, aged 2 years, 2 years 4 months and 2 years 8 months served as subjects. None had been subjects in Experiment VI. Two of the children were tested weekly until they had succeeded in all tasks. These children took five and six weeks of testing before they passed all items. The other child was tested for five weeks, but by the end of that period he was so difficult to test his mother felt it was not right to make him continue. All the children passed a preliminary test of a version of Piaget's Stage VI Object Permanence task.

Procedure

The procedure was as in Experiment VI. If an infant passed in one category for two weeks in succession, then on the third week he was given a reversal trial (for Categories 1, 2 and 4) where the test cups were reversed left to right or right to left of the stimulus cups. For example, if the raisin was under the yellow cup in the representation, and that cup was on the right of one picture, then the yellow cup with raisin was on the child's left. Thus it could be determined whether the child was using the features of the cup in the

representation (its colour) in guiding his choice or merely its location, i.e. the position of the cup to right or left. No such reversal trials could be given with Category 3, so if infants passed in this Category on two successive occasions, they were not tested with that Category again.

RESULTS

Each infant's scores on the five occasions of testing with the four categories are shown in tables 12, 13 and 14. Successes are marked with an asterisk and reversal trials with an R. Where pertinent vocalisation occurred during a trial, the entry for that Category is underlined.

TABLE 12

Results of infant (A) aged 2 years at start of testing.

Category	Trials (order of presentation in parentheses).				
	1 (3214)	2 (2314)	3 (4312)	4 (1342)	3 (3412)
1	58.33	41.6	58.33	58.33	<u>75.00</u> x
2	58.33	58.33	66.67	66.67	50.00
3	25.00	66.67	58.33	50.00	50.00
4	50.00	41.67	58.33	66.67	25.00

TABLE 13

Results of infant (B) aged 2 years 4 months at start of testing.

Categories	Trials (order of presentation in parentheses)				
	1 (4231)	2 (1234)	3 (3412)	4 (2143)	5 (134)
1	58.33	66.67	<u>91.67x</u>	<u>91.67x</u>	R <u>91.67x</u>
2	25.00	75.00x	100.00x	R <u>83.33x</u>	
3	33.33	50.00	50.00	66.67	83.33x
4	66.67	50.00	91.67x	<u>91.67x</u>	R 91.67x

TABLE 14

Results of infant (C) aged 2 years 8 months at start of testing.

Categories	Trials (order of presentation in parentheses)					
	1 (4312)	2 (3142)	3 (2143)	4 (132)	5 (213)	6 (1)
1	58.33	58.33	83.33x	91.67x	R 50.00	R91.67x
2	66.67	66.67	75.00x	100x	R 100.00x	
3	33.33	66.67	58.33	83.33x	100.00x	
4	83.33x	91.67x	R 83.33x			

Table 15 shows the mean success rates on trials in a particular Category on the trial before the first pass trial.

TABLE 15

Success rates on trial previous to the first pass trial in the four Categories.

Infant	Category			
	1	2	3	4
A	58.33	-	-	-
B	58.33	25.00	66.67	50.00
C	58.33	66.67	58.33	-
Mean	58.33	45.84	62.5	50.00

In successful trials with the tasks in the various Categories, the children typically studied the representation before making a choice; on one occasion a child arrested a movement towards the wrong cup, looked at the photograph again and picked up the correct cup.

DISCUSSION

Infant A passed trials in Category 1 first, while Infant B passed the Categories in the order 2413 and Infant C in the order 4213, and so the order of difficulty of solving tasks in the different Categories cannot be assessed, although it would seem that Category 3 was most difficult. The fact that on five of the possible six reversal trials the infants succeeded in passing the test first time indicates that they were using the features of the correct cup in the representation

to guide their choice and not its location.

Nevertheless since the children did manage to pass in Category 3 where feature identification was not possible and only position information was available, it is obvious that position information could be used. The lack of featural information may well have made this task most difficult, particularly when the vocalisation evidence is considered. The only vocalisation which occurred in a Category 3 task was "just like the pictures", while vocalisations in the other Categories included "it's the same" "not the yellow one" "it's the same, spotty one". These children did not seem to be able to identify position by the labels left and right, but could identify the different colour features. "It's the same" meant "it's the same colour" since this vocalisation took place on a reversal trial.

Vocalisation did not seem to be a necessary prerequisite to passing a test, although vocalisation occurred on 44.44% of first successful trials in any Category. The children seemed to be informing the experimenter of the strategy they were using to solve the problem. However, that the younger infants could not solve this task because they had no means of relating the representation linguistically (whether articulated or not) to the tasks seems likely. In this experiment the youngest child, whose speech was less well developed than that of the older children, succeeded on only one task after 240 trials with the stimuli.

That one child passed in Category 2 first suggests that it was not the pictorial nature of the stimuli in Categories 1, 2 and 3 which made these Categories difficult, and that both successful children passed in all the different categories within a relatively short period implies that the same ability was being tested in each Category

of tasks. Children were performing at a chance level on the test before the first successful test in each Category, indicating that this ability is discontinuous.

All the mothers complained that the children repeatedly asked them about the experiment at home and that they disliked prevaricating about the nature of the task, and although they had been asked not to tell the children how to do the task, they may have inadvertently given them hints; for example, by referring to the cups by colour.

The means by which the children solved these tasks cannot be ascertained from this study. What is interesting is that the tasks were so extraordinarily difficult for the children, and that the degree of difficulty seemed not to be related to the fidelity of the representations of the test situation but to the difficulty the child had in relating the cups in the representation to the cups in the test situation. The children seemingly could not see that the stimuli represented the test situation without the mediation of language, articulated or not. This took place in a situation in which imitation was possible, i.e. in Category 4. The child need only repeat the experimenter's action to be successful in finding the raisin.

The fact that experimenter and subject were acting on different objects should not have been relevant; Piaget did not observe infants trying to pull his hair at 13 months of age after he had done so; they pulled their own hair.

Thus at an age when children are capable of deferred imitation of complex acts seen many hours previously, of images and of material objects, and of producing their own metaphors, (Piaget 1945/62) in a situation in which one set of objects must be taken to represent another set of objects the children are not immediately successful.

CHAPTER 11IMITATION IN EARLY INFANCY : A REVIEW

The results of Experiments V - VII must be treated with the caution obligatory in dealing with negative results. I shall discuss the limited implications of these experiments in Chapter 16. However, I believe that the fact that some of the findings reported in Experiments I - IV have been confirmed by independent research in imitation (Maratos 1973; Metzoff and Moore, 1977) allow more detailed consideration of that section of my thesis. I describe these other studies below.

Maratos's study

Maratos studied 12 female infants, who were tested in their homes every fortnight from 1 - 6 months of age. A variety of gestures were performed in front of the infant and the infant's behaviour recorded on a checklist by hand. Maratos compared the frequency of the movements made by the infant during the modelling period with the frequency during a 12 minute baseline period before testing began, during which the frequency of all the behaviours to be modelled had been noted (by hand). There were three groups of tests and these groups were presented to the infants in random order. These were -

Visual

1. Tongue protrusion.
2. Tongue protrusion accompanied by the sound "m".
3. Head shaking.
4. Head shaking accompanied by the sound "a".
5. Opening and closing the mouth.
6. Moving the fingers.

and from 4 - 5 months

7. Bringing hands together.
8. Scratching and banging.

Kinesthetic

9. Baby's leg straightened and bent rhythmically by E.
10. Baby's arm taken by elbow and moved up and down parallel to the body.

11. Both legs straightened and bent alternately by E.

Auditory

12. Vowel sounds in infant's repertoire.
13. A recording of another infant babbling.
14. A recording of another infant crying.

Each test was repeated three times. The imitation Maratos found seemed to vary with age. Thus infants did imitate Test 1, Test 2 and Test 5 up to two months of age and 3 and 4 up to four months of age, while 6 was not imitated until two months of age. One infant continued to protrude the tongue in imitation until 5 months of age. Results for tests 7 and 8 are not reported. Test 9 was imitated at one month, while 10 was not imitated until about 2 months of age. The results for Test 11 are not reported and those for 12 - 14 need not concern us here.

Maratos' results with respect to tongue protrusion, mouth opening and finger movement are consonant with my own. It is interesting that Maratos also found tongue protrusion to be imitated more often than mouth opening; but the result for head shaking is surprising, given that her infants were in the same position as the infants in Experiment I, i.e. supine with a pillow as head support. On 24 out of a possible 36 (12 infants x 3 trials) occasions, the infants were observed to move their heads. This occurred in only 5 out of the possible 144 (12 infants x 12 time periods) occasions in the baseline period. This discrepancy between Maratos' result and my own, may in fact, be due to her applying less stringent criteria. Thus an imitative response is "a quick slight horizontal movement of the head round the mid line" while the spontaneous movements are "of greater amplitude and slower than the movement obtained in limitation of the model"

(Maratos, 1973). This "imitative response" is not the imitation of head shaking Piaget described.

Melzoff and Moore's study

Melzoff and Moore's (1977) study is more interesting, not least because it reports findings of facial and manual gestures in infants less than three weeks of age - in fact Melzoff noted tongue protrusion in imitation at the age of one hour. In the first study six infants were exposed to four models in random order, after viewing a passive-face condition.

1. Tongue protrusion.
2. Mouth opening.
3. Lip protrusion.
4. Opening and closing the hand while moving the fingers.

Each of these movements was modelled four times in 15 seconds, and then E (the model) kept his face still for 20 seconds.

The infants' behaviour was videotaped. The tapes were scored by observers unaware of which of the models was present. Some were asked to rank-order four possible models of facial movement (mouth opening, tongue protrusion, lip protrusion, passive face), as to which they thought most likely to be the model for the tape recording in question. Other coders assessed the finger movement data, rank ordering four possible models of hand movement (sequential finger movement, finger protrusion, hand opening or passive hand) as to which was the most likely to be being presented. The coders were significantly more likely to identify the correct than an incorrect model for both facial and manual gestures.

These results are consistent with my own, except for the sequential finger movement data. I did not find evidence of a simpler hand behaviour being imitated before 13 weeks of age. Melzoff and Moore

report no baseline measures (for the passive face condition, for example), in this study, and it may well be the case that sequential finger movement is simply a more common movement than finger protrusion, passive hand or hand opening under any conditions of stimulation. Alternatively, infants may be more adept at this form of imitation at 2 - 3 weeks than at 3 - 13 weeks.

Melzoff and Moore considered that E might still be influencing the infants' behaviour in the first experiment reported, shaping their behaviour to seeming imitation by subtle alterations in the stimulus; in their second experiment, they employed a different procedure to exclude this possibility.

They found imitation of tongue protrusion and mouth opening in twelve infants aged 2 - 3 weeks when the infant was prevented (by a pacifier) from making these movements during the modelling periods. This procedure prevented the experimenter from giving any possible reinforcement. The results were as shown in Table 16.

TABLE 16

Total number of tongue protrusions and mouth opening movements in the baseline period and under two conditions of stimulation (Melzoff and Moore, 1977)

<u>Infant behaviour</u>	<u>Baseline</u>	<u>Model</u>	
		Tongue protrusion	Mouth Opening
Tongue protrusion	15	40	14
Mouth opening	2	2	8

Each of the 12 infants was exposed to each of the models for 150 seconds. The mean frequency of tongue protrusions for infants exposed to that model in Melzoff and Moore's study was thus 3.33, and for mouth

opening when mouth opening was modelled was 0.67. These results are markedly lower than those I obtained in Experiments II and III where the corresponding means were 12.08 and 7.285 respectively (for 5 minutes and 4 minutes).

This anomaly may simply be a consequence of the difference in procedure between the two studies; or may have arisen because as Piaget states, the mother is more readily imitated than a stranger; Melzoff and Moore's criteria for imitation may have been more stringent than mine; or the mothers may have been influencing the infant's behaviour in my study in non-obvious ways. I have already given the reasons why I think this latter hypothesis to have been unlikely.

Melzoff and Moore do not comment on the disparity in frequency of the two movements, tongue protrusion and mouth opening, and yet this is an interesting finding, confirming my own. Since the mouth must be opened (at least slightly) in order to protrude the tongue, it can hardly be the case that one movement is more difficult to make than the other.

Melzoff and Moore postulate that the infant can represent visually and proprioceptively perceived information in some form common to both. Thus, all he need do in order to be able to imitate is to compare his own sensory information about parts of his body he cannot see with some "supramodal" representation of the visually perceived gesture and construct the match required. "Supramodal" is used as it is in Bower (1977). Presumably the infant acts, possibly incorrectly, and then compares, and then having made the match acts again; but if this model is correct it is ^{not} surprising infants are not more precise in their imitative movements, which Melzoff and Moore characterise as being "lacking in stereotype"; by which presumably they mean inexact as well

as different. Infants surely cannot represent proprioceptively perceived information in a common form with visually perceived information until they have obtained the proprioceptively perceived information, i.e. made the movement. Having made this movement in Melzoff and Moore's study infants did not it seems on the mouth opening evidence go on to act again.

Melzoff and Moore conclude that the ability to act on the basis of an abstract representation of a perceptually absent stimulus may be the start and not the culmination of psychological development (as Piaget believed). Their study did not demonstrate deferred imitation, which takes place in the absence of the model, and not simply when the model has ceased to make a particular movement; this conclusion is unjustified.

The results of the four studies of early infant imitation of some facial and hand movements (Gardner and Gardner, 1970; Maratos, 1973; Melzoff and Moore 1977) and that reported in this thesis are presented in Table 17.

TABLE 17

Age at which evidence of imitation of a number of movements has been found in four studies.

		60 mins.	1 week	2 weeks	3 weeks	4 weeks	6 weeks	8 weeks	Not found by 13 weeks
Tongue protrusion	M & M				D	M	G & G		
Mouth opening			M & M		D		G & G		
Lip protrusion			M & M						
Head shaking						M			D
Head nodding									D
Finger movement								M	D
Eye closing					D				

It seems likely that young infants are capable of imitation of certain facial movements, although the data on head, hand and finger movement is open to other interpretation. That older infants are not able or willing to make all of these movements is well-documented, e.g. Piaget's (1945/1962) Uzgiris' (1972) and Maratos' (1973) longitudinal studies.

EXPLANATION OF RESULTS

Why should infants be capable of imitation in the early weeks of life and yet seemingly be incapable of imitating the same acts a few months later, and then later still be capable again?

There are several explanations of this phenomenon of seeming early infant imitation which could obviate the necessity of classifying it as true imitation.

Firstly, the imitation observed was not always reproducible on another occasion of testing. "Pseudo-imitation" as described by Piaget is also not reproducible on subsequent occasions. It occurs when there is mutual imitation. Thus, if an infant protrudes the tongue, and an adult repeats this movement, the infant may protrude the tongue again; this occurs because

"a temporary association is formed, which makes him continue the action, the model then serving as a stimulating signal" (Piaget 1945/62)

In Experiments I - IV I took pains that the infant should not have made the movement to be modelled before the model herself did so. However, pseudo-imitation may in some cases be lasting, according to Piaget;

"... training leads to pseudo-imitation; which can be produced much more easily and therefore takes place

earlier (than true imitation) tending, since it is kept up by practice, to overshadow the manifestations of spontaneous assimilation" (Piaget 1945/62).

In this case the infant is completely unaware of the correspondence between his action and the model's action; he makes the correct movement, possibly by chance, and this association is strengthened by the adult's show of approval. Piaget is proposing that the adult can shape the infant's behaviour to a seeming imitation. In my experiments, however, the mothers were unaware of the purpose of the experiments, and so were unlikely to be shaping the infants' behaviour to my satisfaction; and if they were doing so, if they did in fact practise with the infants between tests, then their efforts were rather ineffectual. Why should they succeed with tongue protrusion and mouth movement, but not with finger movement, head shaking and so on? In any case, were the mothers training the infants one would expect an amelioration of performance on the second occasion of testing, and not a deterioration - which was generally the case.

A second explanation might be that this phenomenon is similar in nature to other infant abilities which are present in the first weeks of life but which disappear and then reappear later, e.g. walking (Zelazo et al. 1972) and reaching (Bower et al. 1970a, Bower 1974). In the case of imitation, the infant might have some innate tendency to imitate certain acts, which might even be reflexive, and which did not involve representation. This however does not seem to be a sufficient explanation. In the first place, in normal circumstances reaching and walking disappear entirely, to reappear at some later date in the infant's repertoire. The longitudinal reports of infant imitative development give widely divergent observations to the age of attainment of imitation of the same and different actions, but

there is no age at which imitation cannot be elicited, if the observations in those reports are considered as a whole (Valentine 1930, Piaget 1945, Maratos 1973). Both reaching and walking can be elicited from every normal baby in the right circumstances. This is patently not the case with infant imitation. Nor can it be assumed that the circumstances were uniformly adverse, since most infants imitated one gesture during the experiments I conducted.

A third explanation is that imitation in early infancy is in fact not imitation at all, but a fixed-action pattern, with the model's action the sign-stimulus, to use Tinbergen's (1951) term. A hungry herring gull chick will peck at the red spot on its parent's bill soon after hatching; it will not peck so frequently at spots of different colour. The red patch is the sign-stimulus for pecking by the chick; and this response is adaptive, since it leads to the chick being fed. Eibl-Eibesfeldt (1978) has recently proposed that such a mechanism underlies early infant imitation. If this were so, it would be the only known case of the sign-stimulus and the response being identical. One would expect that the response would be reliably elicited in all infants in a well-developed form, and yet imitation seems to be difficult to elicit in some infants. Even those who do imitate show evidence of learning before they produce the correct response, as I have already described. If fixed action patterns underlay imitation of mouth opening and tongue protrusion, which has been observed in very young infants in my own studies and in those by Melzoff and Moore, then it is surprising that both these studies find that the latter occurs more frequently than the former. Nor can this hypothesis explain why infants should cease to imitate certain models, and begin to imitate new ones at later ages.

It seems then that neither explanations of pseudo-imitation, operant conditioning nor fixed-action patterns are sufficient to explain the phenomenon of seeming imitation.

However, it is still the case that the imitation observed in young infants seems to be most easily and reliably obtained to a model moving a part of the face. It might be true that facial movement is somehow privileged in imitative behaviour, and that the competence is not general. The knowledge that facial movement is a large component in social interaction lends support to such an hypothesis. I shall discuss the question of how imitative performance might be achieved, and in which circumstances, in Chapter 16.

An argument against any imitation of facial movement in particular could be made on the basis of the large body of data on infant smiling. This appears to show that infant discrimination of facial features is extremely limited. As recently as 1969, the evidence from these studies could be accurately summarised thus

"by five months of age several features of the human face have been perceptually differentiated : its plastic, solid surface; the eyes as features; the eyes in a characteristic orientation; the mouth as a feature; an oval head shape. But individual faces are not yet differentiated, nor are expressions (smiling and crying). After five months ... alteration of contour and feature arrangement are noted. The uniqueness of individual faces is appreciated some time around six to seven months" E.J. Gibson 1969.

Such limited discriminative ability would not permit an infant to differentiate between e.g. an opening of the mouth and a protrusion of the tongue. Nonetheless, these conclusions were drawn in large part from the classical studies of smiling.

A recent experiment on smiling I carried out with T.G.R. Bower is
apposite to the question of infant discriminative ability.

* A paper based on this research, "Quantitative and Qualitative differences in the smiles of infants 6 to 12 weeks old" by J. Dunkeld and T.G.R. Bower, has been submitted for publication.

CHAPTER 12

SMILING IN INFANCY

The infant smile has been used as an indicator of discrimination in numerous experiments. The results of many of these investigations have seemed to show that although besotted parents might wish to attach meaning to the fact that infants smile at them, this is not the simple case it appears. Infants seem only to be smiling at faces as an example (which is not particularly effective) of a certain class of stimuli likely to elicit smiling. That is, infants will smile as readily to a strange as to a familiar face, or to a completely different stimulus. If infants show such indiscriminate response at the relatively advanced age at which they begin to smile, then an argument for even younger infants' ability to discriminate the movements of individual features in a face is difficult to defend.

Before considering the different hypotheses as to the origin of social smiling, and the experimental evidence in support of those hypotheses, the first question to consider is when the social smile actually appears, and environmental effects on its date of appearance.

Time of origin of social smile

The nativist hypothesis is that the smile emerges, fully-formed at some date after birth, elicited by e.g. high-contrast stimuli or by some aspect of human beings, etc. The empiricist hypothesis is that the time of emergence of the first smile will depend on environmental events in the infant's life, e.g. how long he has been given sufficient experience of response-contingent relations to be able to detect contingencies, or the age at which he can discriminate familiar from non-familiar objects.

When does the smile first occur then? It has been observed that

premature infants smile at the conceptual age of 4 - 5 weeks (Dittrichova, 1969) indicating that their longer exposure to events in the environment did not accelerate the appearance of smiling, since that is the age at which normal infants smile. Infants in an institution where they received minimal social interaction with adults or other children were observed to smile socially at the same age as other infants (Provence and Lipton 1962). However, other investigators have found that amount of social stimulation does affect age of onset of social smiling (Spitz and Wolf, 1946; Wolff 1963; Ambrose 1961; Gewirtz, 1965).

A recent study by Foley (1977) found that the first social smile in premature infants was postponed by pre-term delivery by a factor equal to approximately half the deficit in gestational age. Her 51 subjects were either premature or premature and light-for-dates, so the possible effects of low birth weight were controlled. In addition, the subjects were drawn from two different hospitals and there were significant differences between the infants age of first smile depending on which hospital they were born in.

The results of Foley's study suggest that there may be a genetically determined age before which social smiling cannot be elicited, but that the appearance of social smiling after that age can be delayed or accelerated by environmental factors.

Hypotheses about the origin of the social smile

The hypotheses about the origins of the first social smiles which have been proposed can be classed as shown below.

1. The smile as an innate response to social stimulation

Bowlby (1969) and Freedman (1974) propose that the form of the infant's smile is innately given; the organism is so biased that some stimuli (e.g. eye-spots) are more effective than others in eliciting it,

and these effective stimuli are most likely to emanate from adults in the environment than from any other source. Bowlby believes the range of those effective stimuli becomes restricted to those of human origin through processes of learning. Freedman believes that reinforcement is not a causal mechanism in social smiling on the evidence of his study of a blind infant (Freedman, 1964).

2. The smile as an index of recognition of familiarity

Piaget (1936/53) concludes from a study of early infant smiling that "The smile is primarily a reaction to familiar images, to what has already been seen". He also describes the smile as a form of pseudo-imitation, which can be kept up under the influence of repeated stimulation (Piaget 1945/62). There is no intentional convergence between the infant's smile and the model's smile. Kagan has also argued for the smile as a response of recognition; in a study of infant smiling to sculptured face-like stimuli he found that by four months of age infants smiled more to the most realistic of these. This indicated that the infants had developed a schema for human faces, since they differentiated between the stimuli (Kagan et al 1966).

3. The smile as a response to high-contrast stimuli

Ahrens (1954) found in a study of institutionalised infants that a pair of dots on a card were the most effective elicitors of smiles in infants up until 12 weeks of age after which age face-like patterns became more effective. Six dots were even more effective than two. Ahrens compared the infant smile with the patterns of behaviour noted in bird chicks by ethologists, and concluded that the smile was "released" by the "sign-stimulus" of the eye-like dots; a card with six dots on it was thus a "super-normal sign stimulus" (Freedman, 1974).

Salzen (1963) reported that any change in brightness was likely to produce smiling in 7 - 8 week old infants, with a moving face being no more effective than any other stimulus used.

4. The smile as an index of contingency detection

Watson (1973) and Hunt and Uzgiris (1964) both noted that young infants tended to smile during experiments where some external event was under the infant's control. Watson proposed that the infants were smiling in response to the detection of the contingent relation between their movement and its sequelae. The prototypical games which mothers may play with a young infant, e.g. tickling him every time he turns round, provide opportunities for the infant to detect a contingency between some specific behaviour and an event in the outside world. Watson believes that social responses develop through just such perception of cause and effect relationships (Watson 1978). In an experiment with eight week old infants he found that those infants whose head turning produced movement of a mobile suspended over them smiled after several days of experience in this situation. Other infants exposed to mobiles whose movement was non-contingent on infant behaviour did not smile.

Bower (1977) proposed that one way to clarify the issue of the ontogenesis of social smiling might be to consider the smile not as a unitary concept but to examine it qualitatively. Nursery school children and adults have been shown to smile in different ways in different situations (Brannigan and Humphries, 1969, 1972, Grant 1969); might not infants also produce different smiles in different situations? Experiment 8 was designed to test this hypothesis, and to gather quantitative data on infants' smiles in different conditions of stimulation.

CHAPTER 13EXPERIMENT 8

This experiment was designed to test Bower's (1977) hypothesis that infant smiles would be qualitatively different under different conditions of stimulation.

METHODSubjects

Twenty four infants (14 female, 10 male) served as subjects. Their ages ranged from 49 - 91 days (mean 68.25 days, s.d. 13.72 days). Two other boys cried persistently both times they were brought to the laboratory and had to be eliminated from the sample. Five subjects cried on their first visit and were re-scheduled.

All were reported by their mothers to have started to smile - in the case of the youngest infants only a few days before testing. All were full-term, except for one pair of monozygotic twin girls, the oldest subjects in the sample.

Procedure

Infants were settled by their mothers into an upright baby chair, and were supported by blankets. The four conditions, each lasting two minutes, were presented to the infants in a counterbalanced order. A Sony AV3620 ACE VTR in an adjoining room recorded the full face image of the infant via a Shibadon HV 15S camera. An AKG microphone and a For-A-CO VTG 33 timer were connected to the VTR.

Stimuli

Condition I: Contingency detection. Completely out of sight behind the infant, I briefly rattled a 4 x 4 cm. rattle in sight of the infant to his right each time the infant moved his right hand any appreciable distance (4 - 5 cms). In the case of an active infant as time went on I shaped the behaviour towards a larger movement towards the rattle.

Condition 2: High contrast stimuli. Completely out of sight behind the infant, I slowly moved a piece of white card (29.5 x 20.8 cm) towards and away from the infant's face, along his line of sight 30^0 to the right, through approximately 40 cms. On the card were six round black dots arranged vertically in pairs, of 4 cm. diameter, about 1 cm. under than the transverse section of the human adult eye. Centre to centre horizontally the dots were 6 cm. apart, approximately the separation of adult eyes, and 6 cm. apart centre to centre vertically.

Condition 3: Mother. The infant's mother was asked to make her infant smile without touching him or speaking to him. Mothers smiled, nodded and moved their lips as if speaking, standing to the infant's right, with their faces approximately 30 cms. apart.

Condition 4: Stranger. I did not interact with the infant at all until the beginning of this condition. I stood in the same position at the mothers, smiling and nodding constantly, and moved my lips occasionally.

Analysis

Brannigan and Humphries (1969) classification of smiles could obviously not be used, relying as they did on amount of tooth and gum exposure. Using Etzel and Gewirtz' definition of a smile -

"an elongation of the mouth upward and outward, a deepening of the naso-labial folds from the corners of the mouth to the wings of the nose (lines), mouth may be open, wrinkles may form at the outer corners of the eyes as the eyes narrow, and the cheeks may bulge under the eyes"

(1967) which of the astoundingly diverse grimaces were and were not smiles was decided. If the elongation of the mouth was not accompanied

either by movement at the outer edge upwards, or by crinkling of the eyes, the grimace was not counted as a smile. Eye crinkling could be assessed by covering the mouth area. If eye crinkling was apparent, this expression still looked like a smile. Some infants persisted in what can only be described as "smirking" - which may correspond to the "pleased expressions" Washburn (1929) described in much older infants; although the mouth did not move, nor the eyes wrinkle appreciably, the infants somehow gave the impression of smiling. Such smiles (which only occurred in Conditions 3 and 4) were not counted.

The number of smiles in each condition from each infant was noted. The latency and duration of each smile was assessed by means of the timer. Duration could only be accurately assessed by moving the tape backwards by hand and discovering a point at which there was no trace of smiling left.

Qualitative aspects of the smile were also noted. Timed analysis of the changes in the facial configuration were made for each smile, following Etzel and Gewirtz' description (1967). Eye and mouth movements were timed from onset to change or cessation, and in addition looking towards or away from the stimulus and moving the hand to the mouth or the head back were recorded. Movements of the tongue while smiling were also noted: Brannigan and Humphries noticed that tongue protrusion occurred in "excited play" or "delighted surprise" in nursery school children (1972).

Eye movements:

- (1) Eye crinkling, defined as narrowing the eyes so that wrinkling appeared at the outer canthi.
- (2) Closing the eyes.

Mouth movements:

- (1) Mouth curling up at the outer edges, at both sides, or at one (grin).

(2) Mouth extending horizontally.

(3) Mouth extending vertically.

Originally there were to be four categories of degree of mouth opening

(a) Mouth closed (score 0)

(b) Mouth slightly open (score 1)

(c) Mouth half open (score 2)

(d) Mouth fully open (score 3)

but a fifth, (e) mouth very fully open (score 4) had to be appended when some infants managed to open their mouths to an amazing extent.

Tongue behaviour

(1) No appearance of tongue

(2) Tongue inside at edge of lip or tongue protruded beyond lips.

Looking behaviours were

(1) Looking at stimulus while smiling

(2) Looking away from stimulus during or at the end of a smile.

In addition note was made of all instances of moving the head back, and of putting a hand to the mouth.

Results

The use of chi-square to compare the smiles of the same infants across different conditions is not strictly legitimate; since the subjects in each condition comprised the same infants, clearly there will be some correlation. Since, however, such a correlation would act to reduce the significance of any real differences between smiles, we regard the use of this statistic as conservative, in underestimating any true differences.

Table 18 shows the number of smiles produced by the infants of each sex in each condition. In parentheses is the percentage of the total number of infants of each sex who smiled in each condition.

TABLE 18

Number of smiles produced by the infants of each sex in each condition.
(Percentage of the total number of infants of each sex who smiled in parentheses).

Condition	F.	M.
1	10 (42.9)	9 (40)
2	13 (50)	22 (90)
3	28 (71.4)	36 (80)
4	46 (85.7)	43 (90)

Table 19 shows the mean latency, and Table 20 the mean duration of smiles in each condition by each sex, in minutes, seconds and hundredths of a second.

TABLE 19

Mean latency of smiles in each condition by each sex, in seconds and hundredths of a second.

Condition	F		M		χ^2 test of difference between F and M means
	Mean	s.d.	Mean	s.d.	
1	25.38	24.17	23.89	17.31	n.s.
2	57.44	36.48	75.72	36.52	n.s.
3	29.42	25.46	26.84	24.78	n.s.
4	38.59	41.29	40.08	26.26	n.s.

χ^2 test of difference between conditions

F				M			
1	2	3	4	1	2	3	4
1	xx	x	xx	1	xx	n.s.	n.s.
2		xx	xx	2		xx	xx
3			x	3			n.s.

* p < .025

xx p < .001

Although the boys' latency for each condition did not differ significantly from the girls', the differences in latency for each condition were significantly different for both sexes between Condition II and the other Conditions. For the girls latency in Condition I also differed from that in III and IV, and III also differed from IV.

TABLE 20

Mean duration of smiles in each condition by each sex, in seconds and hundredths of a second.

Condition	F		M		χ^2 test of difference between means of F and M.
	Mean	s.d.	Mean	s.d.	
I	1.87	1.08	.093	0.50	x
II	1.60	1.15	2.45	1.76	n.s.
III	2.48	2.32	4.35	4.06	x
IV	2.17	1.29	3.23	2.34	xx

x p < .025

xx p < .01

χ^2 test of difference between conditions

F			M				
	2	3	4		2	3	4
1	n.s.	n.s.	n.s.	1	x	xx	xx
2		x	n.s.	2		x	n.s.
3			n.s.	3			x
x p < .05							

x p < .005
xx p < .001

In every Condition except 2 the duration of smiles was significantly different between the sexes. While the only significant difference between conditions for girls was that between durations in Conditions 2 and 3, for boys all differences in duration between Conditions were significant except between Conditions 2 and 3.

Table 21 shows the different percentages of girls' and boys' smiles in each Condition in which certain changes in form were apparent.

TABLE 21

Percentage of smiles in each condition in which certain eye, mouth and head behaviours were observed

Condition	Eye behaviours				Mouth behaviours						Head
	Eyes crinkle	Eyes close	Look away	Mouth curls up both sides	Grin (mouth curls up one side)	Mouth extends vertically	Mouth extends horizontally	Tongue to lips or protrudes	Hand to mouth	Head moves back	
1 F	100	20.00	20.00	60	20	80	20	20	0	0	
M	88.9	22.2	22.2	66.67	23.3	22.2	11.1	22.2	0	0	
2 F	46.15	15.38	28.08	53.85	15.28	61.54	30.77	7.69	0	0	
M	77.27	0	4.55	81.8	18.18	45.45	18.18	4.55	0	4.55	
3 F	85.71	28.57	35.71	67.86	14.29	46.43	42.86	10.71	0	3.57	
M	94.4	38.89	47.22	91.67	2.78	80.55	36.11	47.22	19.44	13.89	
4 F	88.09	52.17	50.00	71.74	8.70	47.83	30.49	34.78	2.17	4.35	
M	97.67	34.88	53.49	81.4	4.65	58.14	25.58	9.30	11.63	20.93	

TABLE 21 (continued)

Condition	Mean degree of vertical extension of mouth	Condition	χ^2 test of differences between F and M
1 F	2.63	1	$\chi^2 = 49.96$ df = 9 p < .001
M	1.5	2	$\chi^2 = 52.34$ df = 9 p < .001
2 F	2.75	3	$\chi^2 = 73.18$ df = 9 p < .001
M	1.80	4	$\chi^2 = 39.36$ df = 9 p < .001
3 F	2.54		
M	2.27		
4 F	2.45		
M	2.36		

Table 21 (continued)

 χ^2 of difference between conditions

Girls

	1	2	3	4	
1		xx	xx	xx	df = 9 x p < .005
2			xx	xx	xx p < .001
3				x	

Boys

	1	2	3	4	
1		xx	xx	xx	df = 9
2			xx	xx	xx p < .001
3				xx	



FIGURE 9 : TYPICAL SMILES FROM TWO INFANT GIRLS
IN THE FOUR CONDITIONS

Clearly, then, the infants produced different forms of smiling in each condition, and the girls' smiles were different from those of the boys (see Figure 9 and Figure 10). In general, the more the infants crinkled their eyes, curled up their lips and opened their mouths, and put their heads back, the more intense the smiles seemed. Of interest is the fact that one particular behaviour was noted most frequently in Conditions 3 and 4. This behaviour was closing the eyes and simultaneously turning away from the stimulus at the end of a smile. None of the smiles in Condition 1, 5.71% in Condition 2, 7.81% in Condition 3, and 15.91% of smiles in Condition 4 terminated ^{at} thus.

Discussion

Quantitative comparisons of the smiling observed in this study does not lend support to any of the hypotheses about the ontogenesis of smiling described above. None of the hypotheses would predict that infants would smile most often at the stranger. The non-social Conditions (1 and 2) were far less effective than the social Conditions (3 and 4) for both sexes. It must be noted here, however, that there is no means of knowing exactly what the infants were smiling at in a particular condition. It might be argued that the time constraint left too little time for the infants to detect the contingency in Condition 1; but the impression remained that many of the infants had detected the contingency, as judged by their stilling, interested facial expressions and increase in arm movement.

It could be argued that since the mothers and stranger were trying to elicit smiles, that they provided reinforcement for smiling contingently, either by smiling themselves or in some other fashion. The fact that the stranger was smiled at more often than the mother, and that the smiles in each condition were different, suggests that this hypothesis is



FIGURE 10 : TYPICAL SMILES FROM TWO INFANT BOYS
IN THE FOUR CONDITIONS

not correct.

The number of responses in Condition 2 was also low. The difference in number of smiles between girls and boys is accounted for by the fact that one infant (a boy) smiled eleven times in this condition. Boys were more likely than girls to smile in this condition, however. The infants all seemed very interested in the dots, but did not seem to find them particularly amusing. Ahren's study (1954) in which he showed that eye-like dots were the most effective elicitors up until 12 weeks of age was carried out with institutionalised subjects. Differences in amount of social stimulation received between his sample and mine may well account for the disparity between our results.

The mother (Condition 3) elicited far more smiles from infants of both sexes than Conditions 1 and 2 did. This result supported Piaget's (1952) and Kagan et al's (1966) position on the smile as a response to familiar stimuli, but the finding that the stranger (Condition 4) was even more effective than the mother did not. More of the infants of both sexes smiled more often at the stranger than at any other stimulus. This result is contradictory to Wolff's (1963) claim that strangers were only as effective as mothers (although neither he nor the mothers ever smiled in his study), and to Bowlby's claim (1969) that by three months of age mothers were more effective. It may be that Bower's (1977) explanation of attachment through communication routines of increased specificity is relevant here. Only seven of the infants had an older sibling; and so the mothers' experience of infants was likely to be much less than mine. I may over years of infant observation have learned more routines of communication than the first-time mother of a six week old infant has had time to do.

The results of the analysis of duration and intensity support Polak

et. al's (1964) finding that infant smiles at three months were quicker and longer to social (real face) than to non-social (photograph of face) stimuli, since the social stimuli in this experiment were smiled at faster and for longer than the non-social stimuli.

The results of the qualitative analysis of the smile indicates that there are differences in form between the smiles in the different conditions, and so the hypothesis that infants smile differently in different situations is confirmed. The dimensions of these differences are not clear, but it seems that smiles to social stimuli (Conditions 3 and 4) are characterised by far more eye crinkling, mouth curling, and mouth extension horizontally, than the smiles to non-social stimuli (Conditions 1 and 2); in addition the mouth is opened vertically to a greater extent in social than non-social Conditions.

The findings on sex differences are difficult to interpret. That boy infants smiled more often and more intensely at social stimuli than girls did is surprising, given that we know that the primiparous mothers of girl infants smile at them more often than the primiparous mothers of boys smile at their infants (Thoman et al 1972).

Whether the differences between girls' and boys' smiles to mothers and the differences between those smiles and the smiles elicited by the stranger arise through mothers and strangers smiling in different ways to boys and girls, or reflect sex differences in the perception of and response to mothers and strangers cannot be ascertained from this study. In the next Chapter I will present evidence that suggests that the infants may have been imitating changes in form.

CHAPTER 14

IMITATION IN SMILING

The observation that adults often smile at infants and infants smile back, that infants smile at adults and adults almost invariably smile back, is not considered as constituting evidence of imitation.

Although Piaget considered smiling a form of pseudo-imitation, he did not believe there was any intentional convergence between the infant and adult smiles on the infant's part, nor any realisation of that convergence. The infant merely learned through reinforcement to produce that particular response to that particular stimulus (Piaget 1936/53).

Freedman (1964) dismissed any possible role for imitation in the development of smiling by reference to Piaget's finding that deferred imitation is not possible until the second year of life. From his own and others' observations of blind and deaf-blind children he concluded that smiling was innate.

The ability to smile is in all probability innate and does not depend for its occurrence on exposure to a model, as Darwin proposed many years ago (1872). The only experiment which might have proved this conclusively was seriously flawed (Dennis, 1935), but it is to be hoped no one will ever attempt to replicate it. Dennis and his wife brought up two infants in conditions of minimal stimulation. Neither he nor his wife were supposed to have smiled in the infants' presence until they were 48 days old. The infants did however smile in the period between the beginning of the experiment and the age of 48 days. The experiment did not begin until they were 36 days old, however, and so it seems most unlikely the infants had never seen an adult smile.

Even if the ability to smile at all is innate, the form of the smile, particularly the social smile, may be learned, possibly through imitation. Before discussing the possible effect of imitation in Experiment VIII, which may have been responsible for qualitative differences between the smiles to different stimuli in that experiment, I will present the normative data on the development of the form of the smile.

Unfortunately most of the classic studies were carried out with institutionalised infants; Wolff's observations (1963) of normal infants are thus most interesting, although he used only a very small number of very precocious infants, and had no recourse to film or videotape records to facilitate analysis of his observations.

Development of the Smile in Sighted Infants

Early, non-elicited smiling.

Premature infants and neonates have been observed to produce smiles in the absence of any known stimulation (Spitz and Wolf 1946, Wolff 1963). Emde and Koenig (1969) have shown that these are not caused by wind, as old wives' tales would have it, but occur almost exclusively during REM sleep, particularly when the eyes are first closed. Wolff's (1963) observations confirm this. These smiles decrease in frequency with age (Spitz et al 1970). Wolff (1963) has described the form of the smile in the following terms:

"The mouth stretches sideways and upwards bilaterally ... the orbicularis oris and other superficial muscles of the mouth are symmetrically involved while the rest of the face is relatively undisturbed. The circular superficial muscles around the eyes do not contract, and there is none of the crinkling at the corners of the eyes which will later characterise the smile".

Ambrose (1969) has also noted unilateral movement of the lips.

According to Freedman (1974) not all neonates are observed to engage in non-elicited smiling (though this may be a result of insufficient observation) but infants who smile frequently at this stage also smile frequently later in life.

Socially-elicited smiling

As mentioned above, the emergence of "social" smiles, i.e. those which occur in response to social stimuli, has been considered to be under genetic control; but the amount of social stimulation the infant receives may be a factor. Wolff has described the form of the social smile in these terms:

"... The eyes are bright and focused, the orbicularis oculis muscles obviously contract and contribute the characteristic crinkling around the eyes: The mouth is pulled far to the sides and upwards and may be open, giving the appearance of a grin rather than a smile".

Stimuli eliciting social smiles

Despite the many studies of stimuli sufficient to produce smiling, I know of none which directly compared moving non-smiling human faces and moving smiling human faces in effectiveness in eliciting smiling from young infants or uneliciting different forms of smiles. Spitz and Wolf (1946) found at the youngest age studied (1 month), that infants smiled more to faces than to other stimuli: but although the face model presented either smiled or nodded, the results are not presented in such a way that the relative effectiveness of these movements can be assessed. A grimacing face was supposed to be as effective as a smiling one; but I believe from examination of the illustration of the grimacing face that, since the lips were elongated and turned up at the edges, it could have been interpreted as a smile.

Kempe and Kempe (1978) have observed that abused children do not smile spontaneously, for reasons which are unknown but might be obvious.

Possible effect of imitation

The first point to make from these descriptions is that the smiles elicited in Conditions 1 and 2 of Experiment VIII were more like early, non-elicited smiling than were those elicited in Conditions 3 and 4. For example, eye-crinkling was observed in only 78% of smiles of Conditions 1 and 2, but 91.5% of smiles in Conditions 3 and 4. Since the normal social smile of adults always involves eye crinkling, this may reflect the effect of imitation.

If there were any imitation of smiling, then the variation between the form of infant smiles to the mothers should be much greater than the variation between the form of smiles to the stranger.

The mothers would be likely to produce a far greater range of form of smile than the stranger could. If this were so, then we might expect that the percentage of smiles to the mother exhibiting a certain characteristic of form would be lower than the percentage of smiles to the stranger exhibiting that characteristic.

Using the sign test, I analysed the results for boys' and girls' smiles to mother and stranger shown in Table 21. The prediction made was that the percentage of smiles to stranger in which a certain characteristic of form was apparent would be greater than the percentage of smiles to mother in which that characteristic was apparent. The null hypothesis was that there would be no difference. The results for girls was significant, indicating more variability in the smiles to mothers ($N = 10$, $x = 2$, $p < .055$). The result for boys was not significant ($N = 10$, $x = 6$, n.s.). There is some evidence, then, that girls may have been imitating the form of the smiles they observed. However,

without evidence as to the form the mothers' and strangers' smiles actually took, it could equally well be the case that female infants show more variability in the smiles they give mothers than those they give strangers, irrespective of the form of the smiles the mothers and strangers produce.

BLIND INFANTS' SMILES

In the absence of any evidence from cross-cultural studies of imitation in smiling, one test of the hypothesis that the form of smiles is at least partly imitated could be made in the comparison of blind and sighted infants' smiles.

Development of the smile in blind infants

At least one investigator (Freedman 1974) has concluded that smiling is innate, on the basis of evidence from blind infants. However, Thompson (1941) concluded from a study of blind infants' smiles that lack of opportunity for imitation prevented their from attaining the normal form. Unfortunately, she filmed only two of her 26 subjects in the first year of life. At seven weeks the smile of a congenitally blind infant was described as "a barely perceptible retraction of the corners of the mouth". Another infant was observed at the ages of 11 and 12 months. The smile he produced at 11 months consisted in opening the mouth and partly closing the eyes, presumably also there was horizontal extension, since the naso-labial fold became prominent; but there was no curling up at the corners. Thompson included a photograph of this smile, which does seem to involve some eye-crinkling. The same infant's smile at 12 months of age was characterised by the mouth curling up at the corners and extending vertically slightly; again the mouth extended horizontally and the eyes were partially closed. Thompson describes the shape of the mouth as "elliptical". Slight eye-crinkling is apparent from the photograph provided. This subject had however been blinded after birth, at the

age of five months. The photographs provided show that these smiles were much less intense than the smiles the much younger infants in my study provided; but the eliciting conditions of Thompson's blind infants' smiles are not recorded.

However Freedman (1964) had to allow that vision facilitated smiling, since his blind subject did not exhibit "prolonged smiling" until the age of 5 or 6 months. He noted in a report on a congenitally blind infant that at the age of 2 months 13 days, the infant's smiles

"while beautiful, were not normal. They seemed to be a series of reflexes firing in rapid succession, so that they appeared and then faded rapidly".

By 3 months 8 days her smiles were more prolonged, but "still consisted of a discrete series, i.e. regular twitching at the corners of her mouth".

Freedman's (1964) report gives the most detailed description of a young blind infant's social smiles, and it is striking that the form of those smiles resembles far more that of early non-elicited smiles than that of social smiling in sighted infants. Freedman has published a photograph of his subject smiling (1974) and although the reproduction is appalling eye crinkling does not seem to be present.

Fraiberg (1974) concluded from her longitudinal studies of blind infants that blind infants do not smile as frequently as do sighted infants. Blind infants produce "muted" smiles; Fraiberg reports that the "joyful" smile of a normal sighted infant rarely occurs in blind infants.

There does then seem to be evidence that blind infants do not produce qualitatively similar smiles to those of sighted children, possibly indicating that imitation may be involved in their smiling response. Having access to a large amount of data on blind and severely visually

impaired infants and childrens' smiles, I decided to apply the same analysis to these as I had used in Experiment VIII, to see if I could identify the dimensions of such differences as might be found.

CHAPTER 15EXPERIMENT IXAssessment of Form of Blind Infants' Smiles

The videotape records of blind and visually handicapped babies' smiles I analysed were gathered for another purpose, as observations of their behaviour in the laboratory, before testing the infants with a therapeutic device. * No attempts were therefore made to elicit smiling other than would occur naturally. Their aetiologies were so different and the results of the analyses so disparate that I shall present the data on each infant rather than amalgamate it.

METHOD

Subjects

Subject A: The cause of blindness in this six month old girl was bilateral anophthalmia. Her general condition was excellent, and her motor development above average.

Subject B: The cause of blindness in this thirteen month old girl was bilateral anophthalmia. Her general condition and motoric development were very good, e.g. she could walk with one hand held.

Subject C: The cause of blindness in this thirteen month old boy was agenesis of the optic tract. His general condition was not good, e.g. he would rock to and fro and indulge in head banging when left unstimulated.

Subjects D and E were dizygotic twin boys of normal motor development, aged 28 months, for whom the cause of visual impairment was Leber's Congenital Amaurosis. Ophthalmoscopic examination revealed that in both infants the macular areas and optic discs were atrophic; there was no recordable photopic ERG and only a very slight scotopic ERG was recorded (3 - 4 microvolts instead of the usual 150 - 250 microvolts). Subject E could however react out and grasp peripherally presented objects; but

* I am grateful to Drs. T.G.R. Bower, I. Neilson and J.G. Wishart for their permission to analyse these videotapes.

Subject D would only reach for large white objects presented at the extremes of peripheral vision.

Subject F was a thirteen month old girl, in whom Lebar's Congenital Amaurosis had also been diagnosed. Ophthalmoscopic records were not available, but the infant's vision was obviously very poor. She would only reach for small pieces of white paper presented peripherally.

Procedure

This was different for all the infants depending on infant state and parental inclination. 30 minutes of observation was made of each child playing with toys and interacting socially with adults, and in the case of D and E observation of their normal behaviour at home with their parents and sibling was also made.

Scoring the tapes

The criteria adopted for scoring the occurrence of a smile were as used in Experiment VIII. Recordings of vocalisation were invaluable in scoring, as without the soundtrack it was difficult to discriminate between smiling and crying. Smiles occurring during social interaction were easiest to score, as the effect on the adult was obvious; smiles in non-social situations were extremely difficult to assess, and it may be that some grimaces which were smiles have been excluded from this analysis, simply because none of the usual criteria could encompass them. The qualitative analysis was as used in Experiment VIII.

RESULTS

Table 22 shows the results of the analysis of the smiles observed in the infants "Eyes close" was obviously not a component of these smiles in infants without eyes, and "Look away" for those infants meant "turn away" during a smile.

TABLE 22

Eliciting condition and duration of smile, and occurrence (x) of eye, mouth, head and hand movements.

Subject	Smile Eliciting condition	Duration in seconds	Eye Behaviours			Mouth Behaviours							Head	
			Eyes crinkle	Eyes close	Look away	Mouth curls up both sides	Grin (mouth side) curls up one side)	Mouth extends vertically	Degree of vertical extension	Mouth extends horizontally	Tongue to lips or protrudes	Hand to mouth	Head movement back	
A	1	Familiar adult touch and talk	0.80	-	-	-	x	-	-	-	1	-	-	-
	2	Mother's voice (?)	1.40	-	-	-	-	-	-	-	0	x	-	-
	1	Mother touching cheek with object	0.80	-	-	x	x	-	-	-	0	-	-	-
	B	2	"	1.12	- ¹	-	x	x ²	-	x	2	-	-	-
		3	"	0.44	-	-	x	x	-	-	0	-	-	-
4		Mother talking, bouncing	1.32	-	-	-	x	-	x	2	-	x	-	
5		Mother puts nose in infant's mouth	1.80	-	-	-	x	-	x	2	x	-	-	
6		Mother kisses	0.28	-	-	-	- ²	-	-	1	x ¹	-	-	x

TABLE 22 (continued)

Eliciting condition and duration of smile, and occurrence (x) of eye, mouth, head and hand movements.

Subject	Eliciting condition	Duration in seconds	Eye Behaviours			Mouth Behaviours			Degree of vertical extension	Mouth extends horizontally	Tongue to lips or protrudes	Hand to mouth	Head moves back
			Eyes crinkle	Eyes close	Look away	Mouth curls up	trin (mouth curls up one side)	Mouth extends vertically					
7	Mother talking, touching	0.34	-	-	-	x	-	x	2	x	-	-	-
8	"	0.92	-	-	x	x ³	-	-	0	-	-	-	-
9	Mother puts nose in infant's mouth	0.58	-	-	x	-	-	-	2	x	-	-	-
10	Mother kisses	0.20	-	-	-	-	-	-	0	x	-	-	-
11	Mother pushes toy in infant's face	1.08	-	-	-	-	-	x	1	x	-	-	-
12	"	1.26	-	-	-	-	-	-	2	x	-	-	-
C 1	Given rattle, shakes	1.04	x	-	-	x	-	x	2	-	-	-	-

TABLE 22 (continued)

Eliciting condition and duration of smile, and occurrence (x) of eye, mouth, head and hand movements.

Subject	Smile eliciting condition	Duration in seconds	Eye Behaviours			Mouth Behaviours			Degree of extension	Mouth extends horizontally	Tongue to lips or protrudes	Hand to mouth	Head moves back
			Eyes crinkle	Eyes close	Look away	Mouth curls up both sides	Grin (mouth up one side)	Mouth extends vertically					
C	2	Given rattle, shakes	0.94	-	-	-	x	-	x	2	-	-	-
	3	Reaches for rattle	1.52	-	-	-	x	-	-	1	-	-	-
D	1	Reaches for toy	1.00	-	-	-	x	-	-	2	x	-	-
	2	Mother talks and plays	0.32	-	-	-	x	-	-	0	x	-	-
	3	"	2.34	x	-	-	x	-	x	1	-	-	x
	4	"	1.20	x	-	-	x	-	-	1	x	-	-
	5	"	1.40	x	-	-	x	-	x	2	x	-	-
	6	Playing with toys	1.22	-	-	-	x	-	x	3	x	-	-
	7	"	0.30	-	-	-	x	-	x	2	-	-	-

TABLE 22 (continued)

Eliciting condition and duration of smile, and occurrence (x) of eye, mouth, head and hand movements.

Subject	Eliciting condition	Duration in seconds	Eye Behaviours			Mouth behaviours			Degree of vertical extension	Mouth extends horizontally	Tongue to lips or protrudes	Hand to mouth back	Head moves
			Eyes crinkle	Eyes close	Look away	Mouth curls up both sides	Grin (mouth curls up one side)	Mouth extends vertically					
8	Drops teddy on floor	0.94	x	-	-	x	-	-	0	x	-	-	-
9	Father gives sweet and smiles	1.40	x	-	-	x	-	-	0	x	-	4	-
10	"	1.76	x	x	x	x	-	x	3	x	-	4	-
11	"	1.80	x	-	-	x	-	x	2	x	-	4	-
12	"	1.06	x	-	x	x	-	x	3	x	-	-	-
13	Throws ball on floor	1.40	-	-	-	-	-	x	2	x	-	-	-
14	Reaching for sweet	0.24	-	-	-	x	-	x	1	x	-	-	-
E 1	Mother talks, plays with objects	1.14	-	-	-	x	-	x	2	x	x	-	-

TABLE 22 (continued)

Eliciting condition and duration of smile, and occurrence (x) of eye, mouth, head and hand movements.

Subject	Smile	Eliciting condition	Duration in seconds	Eye Behaviours			Mouth behaviours			Grin (mouth side)	Mouth extends vertically	Degree of vertical extension	Mouth extends horizontally	Tongue to lips or protrudes	Hand to mouth	Head moves back
				Eyes crinkle	Eyes close	Look away	Mouth curls up both sides	curls up one side)								
2		Throws ball	0.86	-	-	-	x	-	-	x	2	x	-	-	-	-
3		Picks up and throws ball	0.98	x	-	-	x	-	-	-	1	x	-	-	-	-
4		On Father's knee, talking	1.32	x	x	x	x	-	-	-	0	x	-	-	-	-
5		"	0.40	-	x	-	x	-	-	-	0	x	-	-	-	-
6		"	1.08	x	-	x	x	-	-	-	0	x	-	-	-	-
7		Adults hand brought repeatedly in front of face	2.40	x	-	-	x	-	-	x	2	x	-	-	-	-

TABLE 22 (continued)
Eliciting condition and duration of smile, and occurrence (x) of eye, mouth, head and hand movements.

Subject	Smile condition	Duration in seconds	Eye Behaviours			Mouth Behaviours			Degree of vertical extension	Mouth extends horizontally	Tongue to lips or protrudes	Hand to mouth back	Head moves
			Eyes crinkles	Eyes close	Look away	Mouth curls up both sides	Grin (mouth curls up one side)	Mouth extends vertically					
F	1	Father touching and smiling, while in mother's arms	3.40	-	x	-	-	x	2	x	-	-	-
	2	"	2.80	x	-	x	-	x	2	x	-	-	-
	3	"	2.40	x	-	-	x	-	2	x	-	-	-
	4	"	2.24	x	-	x	-	-	0	-	-	-	-
	5	Strange adult offers toy	0.88	-	x	-	x	-	0	x	-	-	-

1 brows knitted
3 upper lip over lower
2 upper lip drawn up over teeth
4 did go to mouth but to put sweet in

Table 23 shows the mean duration of smiles and the percentage of smiles in blind and visually handicapped children which showed particular characteristics.

TABLE 24

Comparison of qualitative differences in the smiles of blind and visually handicapped infants.

Duration	Eye Behaviours			Mouth Behaviours			Mean	Mouth	Tongue	Hand	Head	
	Eyes crinkle	Eyes close	Look away	Mouth curls up both sides	Grim	Mouth extends vertically						Degree of horizontal extension
Blind infants	0.93	5.9	-	29.4	64.7	0	41.1	1.2	47.1	5.9	0	5.9
Visually handicapped infants	1.40	57.7	29.4	35.3	88.5	0	53.9	1.4	88.5	3.85	0	3.85



FIGURE 11: SUBJECT B SMILING

DISCUSSION

The eliciting conditions were so different and the degree of visual acuity present in the infants who were partially sighted was so difficult to gauge that strong conclusions cannot be drawn from this study. The evidence in Table 23 does indicate that the visually handicapped children produced more intense smiles, as shown by the fact that their smiles were lengthier and involved more eye crinkling, and that their mouths were opened wider vertically and extended horizontally more frequently. Comparison of these results with those shown in Table 21 indicates that these smiles were not, however, as intense as those produced by very much younger sighted infants. Some of the smiles, particularly those produced by Subject B, looked very bizarre, incorporating as they did characteristics not observed in the smiles of any other infant either sighted or blind, e.g. knitting the brows while smiling. That this subject could produce more normal smiles is shown in Figure 11.

Fraiberg's observation (1974) that the smiles of blind infants are "muted" is supported by this study. The smiles were however not discrete series of twitches as reported by Freedman (1974) in a younger subject. However, in the blind infants the level of eye crinkling observed was so low and the degree of mouth extension vertically so small that it may be hypothesised that these aspects of social smiles are learned, as may be moving the head back and hand to mouth movements during smiling. That extremely visually impaired infants showed more normal smiling, even though none of them could probably see anything more than 12 inches away, suggests to me that this is learned through observation of others' smiles at close range, possibly through imitation.

IMITATION AND SMILING : A SUMMARY

The results of Experiment VIII confirm Carpenter's (1975) finding of infant discrimination between different adult's faces, long before the age of six months. In addition that Experiment indicated that infants can discriminate between social and non-social stimuli, as indexed by their smiling more frequently and intensely to the former than the latter. The results of Experiment IX suggests that vision is necessary for full expression of the social smile, since the smiles of blind and visually impaired infants were different in form from those of sighted younger infants. It cannot be determined from these studies if imitation plays any part in the development of the smile, as Thompson (1941) suggested. Sighted infants generally receive immediate reinforcement for smiling at an adult who has smiled at them. This reinforcement will often consist in continued smiling on the adult's part, but many other behaviours indicating approbation may be displayed. Blind infants by contrast are less likely to receive immediate reinforcement of smiling. It could also be argued that parents of blind infants are likely to reinforce all the infrequent smiles they see, and so may not shape the infant's smile as the parents of sighted infants do. This is suggested by the finding of anomalous features in Subject B's smiles in Experiment IX.

Evidence of discrimination of features

The smiling studies do however indicate the discrimination of adult features is not impossible for young infants, as might be suggested by the classic studies of smiling. Carpenter's study, alluded to above, showed that by 2 weeks of age infants could discriminate between the mother's and a stranger's face, when these

were presented sequentially (Carpenter, 1975). Discrimination was evident on the first fixation, indicating that this did not take place on the basis of differential movement by the mothers and strangers.

Wilcox and Clayton (1968) were unable to show that 5 month old infants could discriminate between films of smiling, frowning and neutral expressions when total fixation time was measured. More recently, however, Young-Browne et al (1977) have produced contrary evidence. Using an habituation paradigm, they compared the responses of three month old infants to sad, surprised and happy expressions in the same model, presented on slides. Infants did discriminate between sad and surprised and between happy and surprised expressions.

CHAPTER 16Imitation and Representation : An overview

Although the results reported in this thesis concerning representation in older children were negative, and so must be treated with due caution, some of the experiments on imitation were positive. The relation of imitation to representation in Piaget's theory has already been described. Possible implications of the experimental results obtained for that theory and for those others outlined in Chapter I will be discussed below.

Imitation in young infants

The positive results I report on imitation in young infants have been independently confirmed (Maratos, 1973; Melzoff and Moore, 1977). However, these positive results were limited to particular facial movements; more gross bodily movement was not imitated. That infants are able to make some of the fine discriminations necessary for facial imitation the results of the smiling studies suggest.

The difficulties inherent in any study of imitation in young infants are legion, as I hope I have made clear, and easy interpretation of results is impossible. The criteria by which an act was classed as imitative were the strong criteria of

- (1) A clear antecedent-consequent relation between model and subject's behaviour must be reliably demonstrable.
- (2) That that consequent should be unique to that antecedent model, i.e. another model could not reliably produce the same consequent, and
- (3) Antecedent and consequent must be isomorphic.

Methodological rigour dictates that only relatively complete replications of the model's movement are allowed to be considered as

imitation. Approximations, of whatever nature, can not be accepted as imitation. Accordingly the antecedents of any progression in imitation of, for example, tongue protrusion, are not clearly discernible. The product of imitation, the complete replication of an act, if taken as the only proof of imitation, cannot elucidate the process.

The implications of these results on young infants' ability to imitate for Piaget's theory of imitative development are thus limited. Piaget's theory describes the process of imitative development are not merely the products. I will discuss below an alternative explanation of the forces operating in imitative development, after consideration of the negative results of experiments on imitation in older infants. If the phenomenon is however true imitation in younger infants, and not "pseudo-imitation" how can it in Piaget's terms take place before the co-ordination of schemas, which characteristically does not appear until Stage IV in the general evolution of intelligence? Bower et al. (1970b) have suggested that Piaget may have been wrong in believing that the schemas of, for example, vision and touch, had to be co-ordinated one with the other through assimilation and accommodation through experience. Bower et al's experiment indicates that this co-ordination is innate, or at least learned in the first few days of life. Given the evidence that reaching and grasping are present in neonates (Bower et al. 1970b) that foetuses suck their fingers before birth (Liggins, 1972) and that young infants close their eyes when objects are moved towards them, we could conclude that the schemas of hand movement, mouth movement and eye blinking are familiar ones for the very young infant. In that case, why should imitation of hand movement, mouth movement and eye blinking not be possible, since Piaget believes that imitation of any act can take place when the infant has already formed a schema of that action and practised

it, and so is able to assimilate the model to that schema. The problem of how the infant could form a schema of an action he cannot see himself make would still remain.

The results of the experiments reported do not lend support to Bower's theory of development.

That theory, in which he proposes that infants move from abstract to specific representations of perceived events, would not allow for precise imitation in early infancy. If infants were to represent the mother's movement in an abstract form it would surely be in Bower's classification "something is moving" and not as specific as "a tongue is being protruded" or "mouth is being opened" until later in development.

Had I found evidence similar to Gardner and Gardner's (1970) observations of opening and closing the wrong part of the body in a six week old infant, similar to the errors Piaget (1945/62) described, then this would have supported Bower's theory. However, I did not observe any such errors in my experiments, which is not to say that they did not occur. As I have discussed above, my interest lay primarily in correct replications. Any such errors could be of varied nature, e.g. infants might have been moving their toes when the finger movement model was presented. Apart from the near impossibility of recording every infant's every movement without having the subjects naked throughout the experiments, I consider the evidence that such movements are imitative to be weak. Gardner and Gardner (1970) presented four models, two In/Out in mode (tongue protrusion, finger extension) and two Open/Close in mode (hand open and shut, mouth open and shut). Apart from direct evidence of imitation of two of these movements, (tongue protrusion and hand opening and closing) they also analysed erroneous response and concluded that the infant was more likely to produce a

response in the correct than the incorrect mode, e.g. opening and shutting the mouth when the hand was opened and closed, rather than protruding the tongue. However, the table of response they provide shows that the In/Out models elicited 7 In/Out responses and 4 Open/Close responses; the Open/Close models elicited 5 In/Out responses and 8 Open/Close responses, including direct imitation of the model. Since 11 out of the total of 24 responses were tongue protrusion, I believe their conclusions to be unjustified. Piaget's observations were made by eye, and it is impossible to discern all the movements an infant makes and record them at the same time. The "errors" I observed were in my opinion approximate attempts at imitation, with the correct part of the body, e.g. bringing two hands instead of one to the mouth in Experiment IV.

If in the course of development, infants do move from abstract to specific representations of perceived stimuli then one would expect an increase in imitative ability over time, and not as has been found (Maratos 1973) a seeming decrease in this ability for particular acts.

Imitation in older infants

The results of Experiment V were negative, in that older infants generally could not imitate a novel act, although it was one the infants could see themselves make. This result is in accord with the theories Piaget, Bruner and Bower have proposed. Piaget and Bruner would not allow that infants could represent to themselves such a model. The specificity of thought required might not yet be sufficiently developed, in Bower's theory. The results are interesting however for their bearing on imitation in younger infants. Given reinforcement verbally, visually and aurally, the children were still unable to imitate reliably

a simple movement they could see themselves make. This finding weakens the case for the imitation of unseen complex face movement in even younger infants in terms of subtle conditioning.

That the older infants' failure is a result of a deficit in memory is unlikely, given all the evidence for long-term memory in infants of this age. Is it then the case that younger infants are better able to represent observed movement, and therefore reproduce it, than are older infants, or the fact that the tasks presented to the infants differ in terms of familiarity the reason for the younger infants' competence? The finding that one infant could imitate the required actions lends support to the latter hypothesis, and I shall return to this question.

Representation

The results of the experiments investigating representation in the second definition I employed, as an understanding that one thing can stand for another, are not in accord with Piaget's observations on this ability in infants. Competent as the children undoubtedly were in representation as first defined, the evocation of absent images, developed though the semiotic function was as implied by their linguistic development, representation in this second use of the term was far from advanced. The older children did not seem to be able to solve the problem until they were able to attach verbal labels to the representation, although certain of the problems could have been solved by direct imitation.

The results of Experiments VI - VIII are not in accord with Bruner's position. Bruner would allow that the older infant in Stage VI of cognitive development could know something through a picture of it. Although he has emphasised that recognition of a picture does not imply the ability to perform the act it represents, to "know something through

a picture or image of it" (Bruner 1966) implies more than mere recognition. The ability to recognise pictures is in any case present by 5 months of age, if we accept Fagan's (1972) finding that infants preferred a novel photograph of a face to one they had seen two weeks previously. These photographs were presented simultaneously, using the paired comparison technique. Whether the infants were recognising the photograph as a face cannot be determined, but the ability to discriminate a novel from a familiar picture suggests that the latter was recognised. Bruner disagrees with Piaget that the growth of representational ability is stage-like, and believes instead that it consists in successive mastery of the three forms of representation he distinguishes. There is partial translation of each of these forms into its successor. That children did not seem to be able to solve these problems without access to symbolise representation supports Bruner's position.

The results of Experiments VI - VIII do however accord with Bower's theory. Children should have developed representational capacity to a level at which they could specify the relations of objects in a representation to such an extent that they can act on the basis of those relations, particularly if they can specify those relations verbally.

Imitation and Representation

The positive finding of imitation in young infants seems to be the most challenging result for the theories of representation discussed. Above I described possible explanations of this phenomenon, none of which seem to be entirely sufficient. Thus, explanations in terms of operant conditioning or associative learning cannot account for the wide diversity in individual performance, nor the limitation of imitation to facial movement. If operant conditioning was instrumental in producing these responses, then the learning which took place was extremely rapid - more

rapid than is usual with this age range of infants. Nor can imitative performance be a purely reflexive act, as is walking in the newborn; not only does it fail to decline as other such reflexive acts usually do, it does not seem to be reliably elicited in all infants, as such acts usually are. The variability of individual performance also militates against ethological concepts of fixed action patterns as explanations of imitation.

If it is allowed that imitation, albeit of a limited range of models, is present from an early age, then how is this imitation achieved?

Imitative performance

Trevarthen (1975) has proposed that the infant has an innate model of his own and others' bodies, and is able to map the movements of others on to his own body and reproduce the movement. It is this position which Moore and Melzoff (1977) also maintain. However, as I have suggested earlier, if this general competence is present from birth, it is surprising that the performance of individual infants is so variable. Until strong evidence of imitation of body movement other than facial movement is produced, it seems that it would be more parsimonious to limit this innate knowledge of isomorphism to facial models. Jirari's finding that 10 minute old infants preferentially followed schematic representations of whole faces, rather than of scrambled symmetrical or assymmetrical representations or blank faces may be relevant here (Jirari, 1976). Studies of infant preference for face-like representations are notoriously difficult to evaluate, since full consideration of such variables as complexity, brightness constancy etc, is not always achieved. Nevertheless, the infants were so young that this finding may indicate that some model for faces is innate.

Piaget believed that the infant must learn that isomorphism existed between himself and others before he could imitate models of actions he could

not himself make. The fact that the infants in my studies did not immediately reproduce others' actions perfectly, instead making slight errors, of e.g. pushing the tongue against the lips when the mouth model was presented, supports this position. Piaget considered that "mutual imitation" was necessarily involved in this learning. There is now evidence that mothers consistently imitate their infants, which I shall now outline.

MacFarlane (1975) in six transcripts of mothers' behaviour immediately after delivery (collected for another purpose) noted four instances of mothers imitating their infants - in one case, interestingly, of eye blinking. That mothers of eight week old infants frequently imitated their movements was observed by Trevarthen (1975) and Papousek and Papousek (1977) also reported instances of mothers imitating infants. They observed that facial movements were most likely to be imitated in the first days after delivery. In a longitudinal study of infants' and mothers' imitative behaviour Pawlby (1977) observed that mothers' frequently imitated their infants, while infant imitation of the mother was not so common. The infants were between 4 and 10 months of age. Of interest is the fact that mothers imitated infants' acts with approximately the same frequency during the study, while the frequency of infants imitating mothers increased during this time. Forty-nine different activities were imitated by mother or by child, with speech sounds being most frequently imitated throughout the study. There was an increase with age in the amount of imitations involving manual movements and movements with objects, and a decrease in imitation of facial movements. Pawlby noted individual differences between pairs of mothers and infants; e.g. some mothers and infants imitated activities involving toys more frequently than they imitated speech sounds.

If mutual imitation of infant by mother does take place, could it lead to true imitation in the very young infant, as Piaget has described as occurring in older infants?

Papousek and Papousek (1977) believe that it could not. Although they allow that the mother, in imitating her infant and thus providing him with contingent stimulation facilitates the development of imitation, they still maintain that the first such imitation shown will be of sounds. The infant will not be able to learn the correspondence of his facial features and those of others until later. Evidence that infants detect the contingent nature of mutual imitation is also offered. Papousek and Papousek claim that infants often smile when mothers imitate their movement, but do not smile when merely presented with her models. I would dispute this very strongly, as some infants in my studies smiled when the mother first presented a movement, before they had imitated it themselves.

Given the evidence for imitation in the young infant, and that of mutual imitation of child by mother, I believe it would be more parsimonious to consider imitative development as a process of learning, perhaps with some particular facial movements somehow privileged, than as action on the basis of innate knowledge of isomorphism. The importance of imitation in social interaction I shall discuss below. If early imitation is acquired through learning, then what is the nature of the reinforcement for that learning? A consideration of this topic may, in addition provide clues to the nature of representation involved in such imitation.

One hypothesis is that infants find making the match between the actions of others and their own is in itself reinforcing. The problem of how the infant knows that the match has been made still remains.

Innate mechanisms of recognition of isomorphism must be invoked to support this hypothesis. It presumes that the infants can learn how to produce the correct response, and having done so recognises it as such through an innate ability to detect the similarity. If an infant who had never protruded its tongue or seen a tongue protruded in its life were to reproduce this action on the first occasion it was modelled, then this hypothesis could well be correct.

An alternative hypothesis would be that there is some external consequence to making the match. As I have discussed above, Watson (1966) makes a powerful argument for contingency detection as the basis of social intercourse in infancy. If the mother imitates the infant, and the infant detects the contingent nature of her action, then this detection could reinforce the likelihood of the infant's repeating his action, and then the mother repeating hers, leading eventually to a seeming imitation. However, in Melzoff and Moore's study (1977) it was impossible for the model to act in any way contingent on the infant's actions, and yet imitation still took place. This hypothesis would therefore require that the infants somehow generalise a response they made to a previous model, perhaps the mother, to a new model. It is certainly true that mothers imitate infants extraordinarily frequently (Pawlby, 1977). Individual differences are apparent in infants' imitation. It may be then that such generalisation is possible, but that these individual differences reflect the vagaries of individual experience is not yet clear. If infants who had never been exposed to a mouth opening model were less likely to imitate that model when it was first presented than were infants shown such a model previously, then the evidence for such an hypothesis would be stronger. The obvious impossibility of performing such an experiment points up the difficulties

in production of any convincing explanation of early imitation on the data so far available. In any case on this hypothesis there would be no necessity for the consequent act to be isomorphic with the antecedent model, as is necessary on the strong criteria of imitation, or for that antecedent to be unique in eliciting that consequent reliably. The only necessary condition is that the mother's action is contingent on the infant's, and as the timing analysis in Experiment IV showed, mother's and infant's behaviour was to some extent synchronised. However, this was also presumably true in those conditions where imitation was not observed. As yet it has not been shown that an infant through contingent reinforcement will reliably produce a movement completely dissimilar from that of the model as easily as that movement is produced under the same reinforcement of an isomorphic model. Given the evidence of the difficulty of eliciting reliable imitation in young infants it seems to me that if what seems to be imitation is a product of this form of learning then it is a special form of such learning, in which the isomorphism of the contingent acts if not immediately ~~very~~ soon becomes important. Obviously, a mother will not reinforce by immediate repetition of an infant's acts those which are not appropriate to her own behaviour, and acts isomorphic to her own must frequently be appropriate. That negative reinforcement is effective in eliminating undesirable mouth movement is shown by a study describing the success of a mother in reducing tongue protrusion in her Down's Syndrome infant (Numata, 1975).

How would either of these hypothesis account for the emergence of new behaviours? On the view that recognition of isomorphism is given, the emergence of new behaviours is presumably a matter of increasing

motor skill. Certainly, in my view the implications for imitative development of increasing motor skill have been neglected. A two year old child cannot thread a needle, no matter how many times he is shown how to do so, although we may be sure he has a very well developed knowledge of isomorphism. Why moving the arm in a particular way rather than a part of the face should be more difficult could be explained in terms of the importance for young infants of precise facial movement - in nursing, etc., - and the relative unimportance of, and probably motor capacity for, precise arm movement. The neural representation of lip and tongue movement is likely to be greater than that of arm movement in the young infant, as in the adult.

The learning hypothesis, in its original form, where isomorphism is not a prerequisite, must necessitate a two-stage development. The first would be of early non-intentional or representative imitation; the later of "true" imitation, reminiscent of Valentine's (1930) theory. Obviously infants eventually attempt new acts in imitation which they have never before spontaneously produced, and for which they can not therefore have been contingently reinforced. Relying as I did on strong criteria of imitation, to establish the evidence for its existence rather than any development of the ability, any transition between for example opening the mouth to that same model in seeming and in true imitation cannot be ascertained from these studies. On the evidence of Melzoff and Moore (1977), I would argue that it must indeed be one which takes place very early in the infant's life.

Imitation and social interaction

That seeming infant imitation is more easily elicited to facial movements suggests that this ability may be of important social consequence. The evidence from the blind infants studied indicates that lack of oppor-

tunity to see others' facial expressions, may prevent full expressions of the smiling response.

It may be that the decrement in imitation of facial movement noted by some investigators (Maratos, 1973; Pawlby 1977) reflects shaping of behaviour by the mother. Obviously, tongue protrusion is socially unacceptable in infants past a certain age; there is some suggestion that this behaviour is ^{modifiable} as described above. With increasing age it is clear that the range of behaviours imitated correspondingly increases (Pawlby, 1977); this increase may reflect increasing maternal fostering of imitation, (and motor development) and not the steady progress of representational ability. The individual variability observed may result from the variation in mothers' propensity to encourage specific imitations.

The importance of imitation in social interaction, and any effects of social reinforcement of whatever nature, has yet to be established. I would suggest, however, that it is in this area of study that the function of imitation might well be discerned.

Imitation does not seem to parallel representational ability, as Piaget believed. If infants can imitate movements of unseen parts of the body before they can imitate movements of seen parts of the body, then the distinction between these movements made in terms of difficulty of representation may not be valid. If the observations of Experiments VI and VII were to be replicated, then it would indicate that representational ability in the first sense, evocation of absent objects, may not confer the ability to represent in the second sense, that of understanding that one thing can stand for another.

If early infant imitation is a real phenomenon, results of the experiments reported here and Melzoff and Moore's (1977) findings are

verified, then will the nature of the underlying representation ever be discernible? It seems to me that the requirement of immediate repetition of novel movement seen some time previously, which Piaget (1945/62) considered the apogee of infant representational ability, could never be demonstrated in very young infants, for ethical and practical reasons. That children eventually attain this ability is obvious, and so there must be some development in imitation, if not as a function of increasing representational ability. I think it not unlikely that this development is a function of social reinforcement of imitation performed for its own sake, in mutually rewarding interaction. In cultures less technologically inclined than our own, infants have been observed to imitate most of the actions their parents produce in everyday life (Konners, 1972; Turnbull, 1976). In play they learn the skills of adulthood - of hunting, cooking, and so on - through imitation; and are much encouraged in this imitation by their parents. Early imitation may be an epiphenomenon of social intercourse, but it may develop into a real vehicle of learning, through social reinforcement.

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